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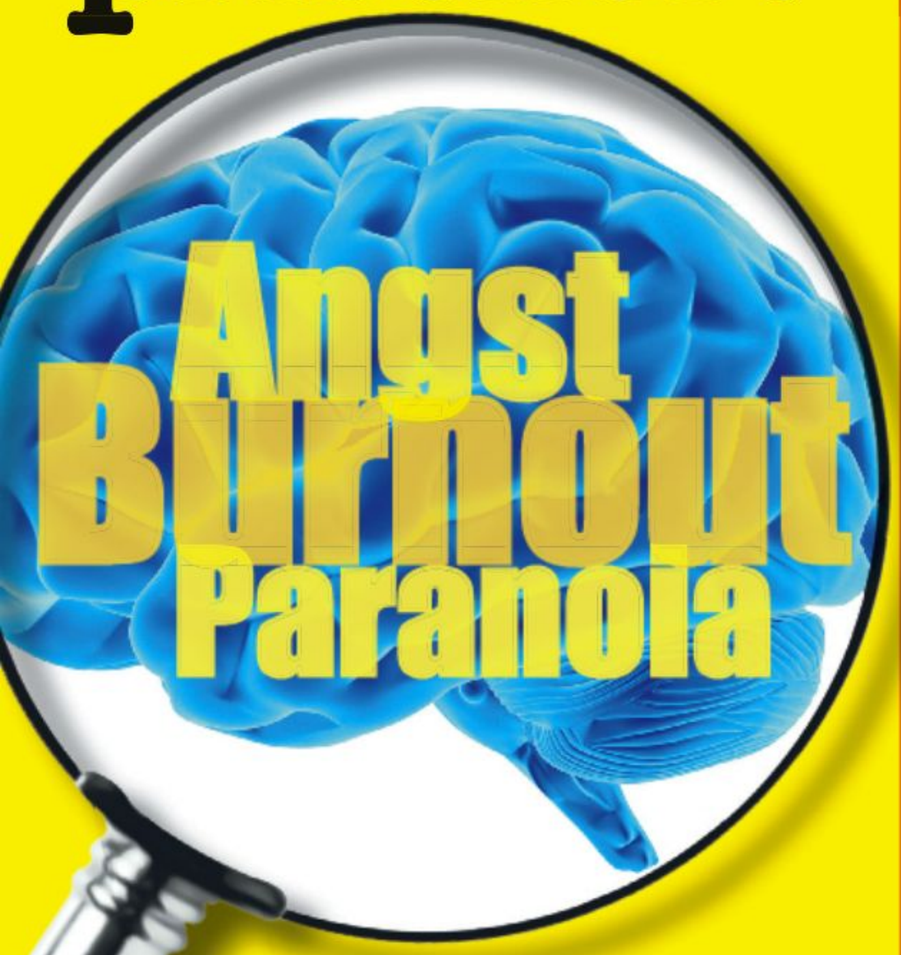

How to free yourself from mental captivity

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ALTERNATIVE HISTORY EXPERIMENT

How one assassination might have changed the world

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Experts in this issue

RUNA SANDVIK
IT security expert
Sandvik (left) and her husband Michael Auger hacked into the electronics of a sniper rifle and succeeded in reprogramming its targeting software.
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» We could permanently manipulate the weapon without the shooter realising. «

» A successful assassination would only have strengthened the Nazi regime. Hitler would have been celebrated as a martyr. «

IAN KERSHAW
Hitler's biographer
More than 35 attempted assassinations on Adolf Hitler failed. Leading historians examine how world history might have proceeded differently had one of the efforts proved successful.
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Director of the Fugro fleet
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MARTIN FASSNACHT
Marketing expert
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WILHELM HOFMANN
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PHOTOS: Greg Kahn; Alamy; DPA; PR (3)

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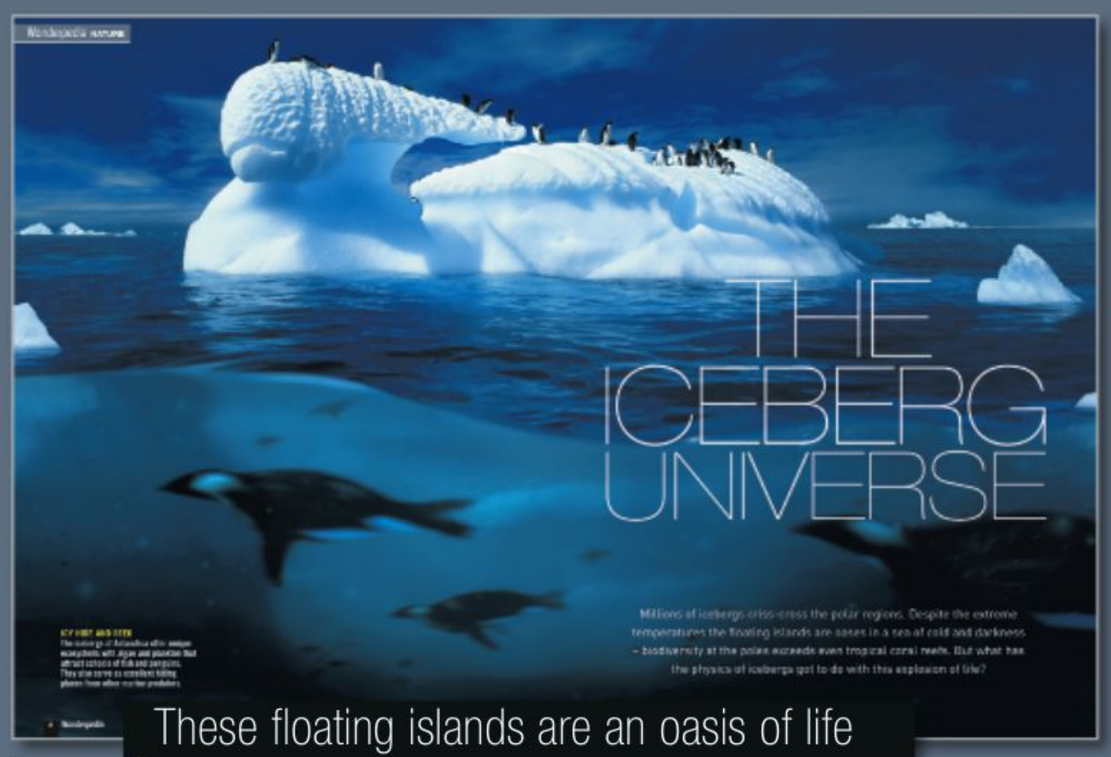

These floating islands are an oasis of life **for the ecosystem**

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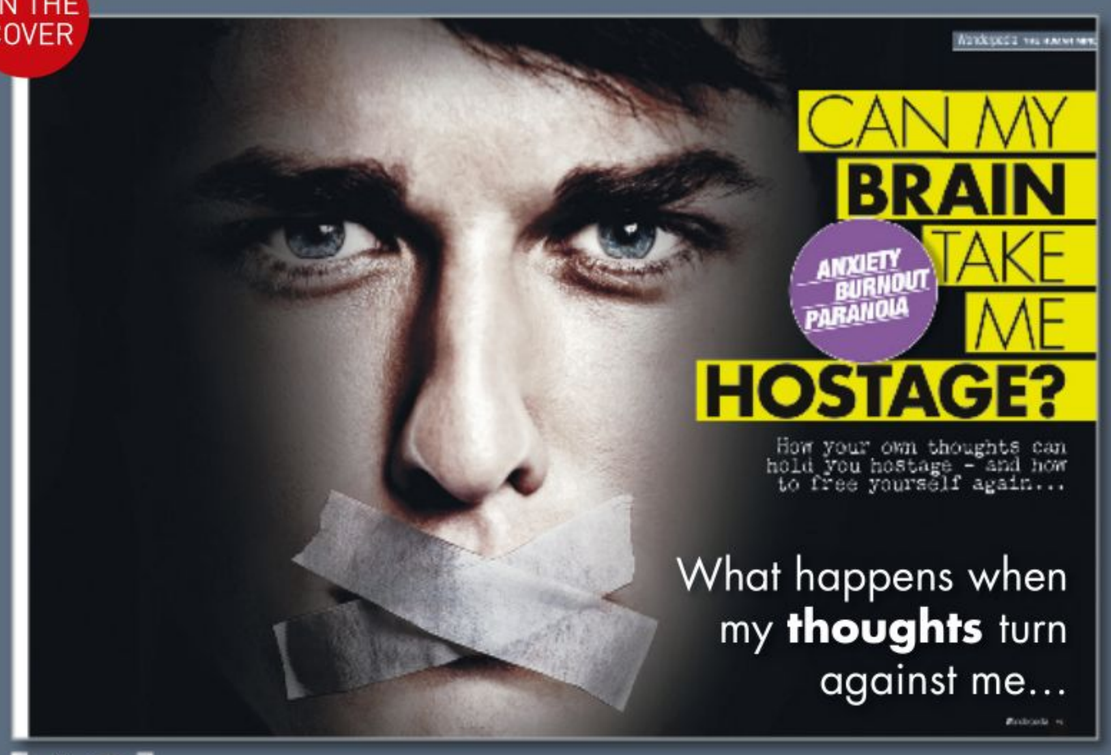

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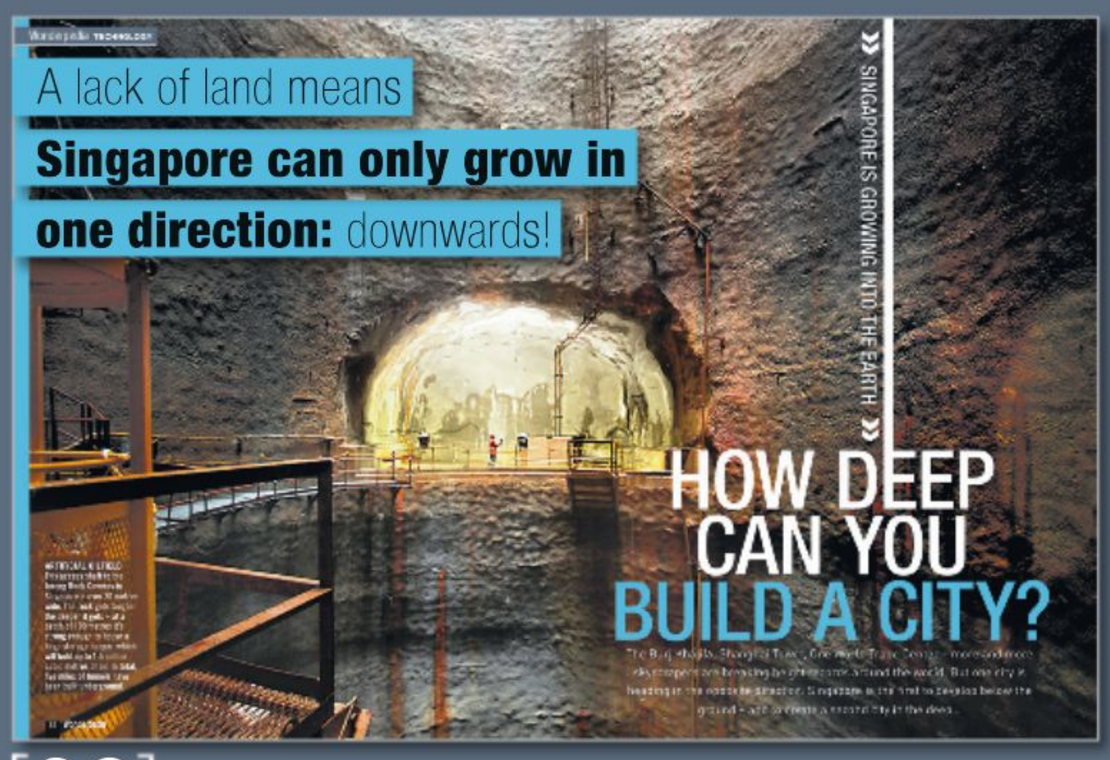

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Clément Dumais is beginning to feel a bit queasy. He glances down at his Geiger counter: 5.2 millisieverts (mSv). That's 17 times over the limit of 0.3mSv and considered physically intolerable. Perhaps he and his three companions should turn back. For days they've been traipsing through the most toxic region on the planet. They've covered 100 miles through dense forests inhabited by wolves. Unseen by military watchtowers and police check points, just a few hundred metres separate the young men from their destination – Pripyat, the Ukrainian ghost town two miles from Chernobyl.

Exactly 30 years ago this was the site of the biggest nuclear reactor accident in the history of mankind. The fallout released 400 times more radioactivity than the atom bomb at Hiroshima. Since then a 60-mile radioactive exclusion zone has been in force. Nobody knows how long a human body can withstand a trip into this death zone without sustaining irreversible damage. But curiosity got the better of fear for Dumais and his crew. Equipped with protective suits and gas masks, they travel deeper and deeper into the ruins of the city, a place where

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PARKOUR IN CHERNOBYL

HOW DO YOU CONQUER A NO-GO AREA?

time seems to have stopped. Nature has conquered civilisation and reclaimed the area: neglected buildings and houses are draped in trees and plants, a theme park stands deserted and rusting at the end of the street, its concrete foundations split open by the root systems growing beneath it.

But the four Frenchmen are not just here for a spot of sightseeing – these adrenaline junkies are part of the parkour collective Hit The Road. The freerunners scale extraordinarily high buildings and overcome obstacles using only their bare hands and feet. And that's why they're clambering up a ladder to the industrial ruin pictured here. They want to witness first-hand the devastation of this once-in-a-century catastrophe.

"It was breathtakingly beautiful – and terrifying at the same time," says Dumais. Eventually he and his pals leave the restricted zone as quietly and unnoticed as they entered it. Just a few weeks earlier they had landed the biggest coup of their parkour career by scaling the 324-metre-high Eiffel Tower, using just their bare hands and with no safety harnesses. Dangerous work – but at least there was no radiation there…

PHOTO: Hit The Road

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ICY HIDE AND SEEK

The icebergs of Antarctica offer unique ecosystems with algae and plankton that attract schools of fish and penguins. They also serve as excellent hiding places from other marine predators.

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THE ICEBERG UNIVERSE

Millions of icebergs criss-cross the polar regions. Despite the extreme temperatures the floating islands are oases in a sea of cold and darkness – biodiversity at the poles exceeds even tropical coral reefs. But what has the physics of icebergs got to do with this explosion of life?

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CLOSE CALL
Every ship requires special protection in Arctic waters. This yacht is armed against collisions with a hull made from specially hardened aluminium.

Can icebergs turn green?

Tiny air bubbles in the ice are responsible for the majestic white sheen of most icebergs: sunlight hits the ice and is scattered in all directions like a million small reflections. In contrast, the common deep-blue streaks in icebergs come from meltwater that has re-frozen without air pockets. This largely transparent ice interrupts the visible light into its component colours like a prism, and it's predominantly the blue part that shines outwards. But there are also green examples whose verdant hue is a result of the frozen algae and plankton found in the water. It's only when they flip over, a rare event in itself, that this rich jade colouring can be seen.

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TEMPORARY ARTWORKS

Sun, wind and flowing meltwater form breathtaking sculptures in the ice. They're sometimes used by penguins as places to catch their breath between dives; exiting the water at speed, they shoot up to 1.8 metres onto the ice before clambering up its smooth walls. The giant masterpiece pictured here is in the Weddell Sea, a partially enclosed body of water in Antarctica. Its shining blue form has been created over the years by salty seawater, but now its meltwater is perfectly drinkable. The reason: icebergs function like massive filtering plants. The salt particles can't attach to the ice crystals because they are too large. The lack of space forces them outside through narrow channels where they eventually trickle away into the sea. After just a few days, the water from the ice giant can be used to cook with.

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How do icebergs nurture life in the oceans?

They might look like frozen wastelands, but in reality icebergs are oases of life. Before they break apart from the ice shelf or glacier, they have often ploughed the ground for hundreds of kilometres, carrying valuable minerals and nutrients with them. These 'seeds of life' are found in net-like structures and grooves on the underside of the iceberg. Once it arrives in the sea, numerous tiny organisms tumble out which sustain molluscs, crabs and other types of crustacean. The biodiversity is so great that it's best compared to a tropical coral reef. But the ice also endangers the lives of any marine mammal that needs to surface to breathe. Wind, waves and currents can completely rearrange the layout of floes on the water's surface in seconds. Because of this, Weddell seals, who boast the best spatial awareness of any seal, memorise every hole in the iceberg over an area of 50 square kilometres and are constantly updating the map in their heads. If they didn't, their 'sat-nav' would be rendered useless in a matter of days.

OFF-ROADER
Raging torrents of meltwater can't stop a hungry polar bear: they are accomplished swimmers and can leap across crevices of up to five metres.

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FATALITIES

In the Antarctic icebergs generate rivers of ice. When the sea hits the ice floes and causes them to melt quickly, the thawed freshwater from the ice decreases the salt content in the sea. This instantly raises the freezing point of minus 1.9 degrees Celsius by about half a degree. But because of its constant movement the water cannot freeze as ice crystals only form in calm, current-protected areas. Many sea urchins and sponges fail to survive this ice inferno.

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THE ICEBERG

he most violent birth in nature begins with an almost inaudible crunch. In the space of mere seconds, this swells to a thundering boom that can be heard for several miles. A gigantic crash follows as the blue and white landscape is torn apart: a 100-metre-wide iceberg collapses and falls into the sea with an ear-splitting roar. A wave, higher than a family home, powers through the water and briefly turns small chunks of ice into deadly weapons. Seconds later the sunken ice mass rises out of the choppy waters. Water cascades off its glistening surface. The colossus is floating free at the start of a journey that could last for 10,000 miles. With a bit of luck it will remain intact for several years; but usually it only takes a few months before the frozen giants are turned into a handful of ice cubes.

'Calving' is the name given to the process that sees a glacier sliding into the sea when parts of the ice break off – some are the size of a small car, others as large as a football stadium. And some are as big as entire countries: one of the largest ever recorded had an area measuring 208 x 60 miles. That's like Belgium breaking away from continental Europe and floating away.

The sluggish giants usually travel less than a mile an hour with the current. However, buried in their tens of thousands of tons of mass is an irrepressible force that can be unleashed without warning. If wind, waves and meltwater make an iceberg's already eroded shape more unstable, it can flip upside down. A shift of just 90 degrees can release as much energy as a mid-level earthquake measuring 5 or 6 on the Richter scale. Its colossal size and shape means it can even trigger a destructive tsunami as it turns.

The iceberg universe might appear to be a frozen landscape, devoid of activity. But in fact, the opposite is true. It's not just individual icebergs that are shifting position, but the vast Arctic and Antarctic ice sheets, too. They are constantly in motion, moving around like a viscous soup. On average, 150 kilograms press on every square centimetre of ice. The constant grinding and groaning is evidence of the enormous forces at work inside the icebergs.

The biggest ice factory in the world never stands still. Greenland alone produces 40,000 new islands of ice every year. But they can also form on the ocean itself when sea water freezes and ice platelets form. Waves and wind help compress these particles into larger plates, which then freeze together into solid ice cover. Millions of icebergs drift around the North and South poles – two sprawling archipelagos whose appearance is constantly being redrawn.

WHEN IS ICE AS TOUGH AS A STEEL GIRDER?

For a ship's captain, navigating in iceberg infested waters is a huge challenge – and not just because it was a relatively small specimen that sunk the Titanic. Despite professional forecasting and centimetre-precise satellite monitoring equipment, icebergs pose an extreme risk for ships.

Even when an iceberg is spotted, the captain can only guess at how it is spread out underwater, given that 90% of its body is hidden under the surface. Explosives and firebombs are of no help against the floating giants either – attempts by the US Coastguard in the 1950s to blow them up proved unsuccessful. They concluded they would need an atom bomb to destroy them. No wonder: an iceberg's appearance can prove deceptive. While its exterior may be melting and crumbling away, inside temperatures of minus 20 degrees Celsius are normal. In here, the ice is as hard as steel. You can carve your name on the iceberg's surface using just your fingernails, but at a depth of ten to 30 metres you'd need an industrial chisel. That's because the crystal structure of the ice holds the molecules together more firmly the lower the temperature sinks.

For oil rigs the heavy, hard-as-steel icebergs pose a greater danger than storms. Mega-platforms like the 224-metre-high Hibernia in Canada's Labrador Sea can withstand collisions with icebergs weighing up to six million tons – but the Ilulissat icefjord off Greenland alone discharges four times that amount into the sea every single day. If really large chunks of ice appear to be on a collision course with a rig, the only option is for ocean-going tugs to tow the iceberg away from the danger zone. If that fails, and a slow-motion collision is inevitable, evacuating the platform becomes the only option.

All of which explains why scientists keep such a close eye on their monitoring equipment. Each groan could herald the birth of a new giant, one that has the potential to erase a massive oil rig from the map…

PHOTOS: DPA; Winfried Wisniewski; Corbis; Laif; BBC/Discovery Channel
ILLUSTRATION: B. Ramis de Ayreflor/wdw-Grafik

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Hunting party

The minerals and algae clinging to the ice attract many microorganisms and krill, which in turn draw the larger predators of the ocean. This is how a circle of life develops around icebergs…

PENGUINS

On the hunt for fish and krill, penguins search directly under the water's surface along the iceberg. But just a few metres under the ice floe lurks their deadliest enemy, the leopard seal. To escape the predator, the penguins accelerate to 15mph in fractions of a second and shoot through these enemy lines like torpedoes.

SEALS

There are 34 types of seal around the world. In the water the quickest accelerate their streamlined bodies to up to 25mph. When hunting for fish they can dive to depths of up to 700 metres.

ORCAS

Killer whales are by far the most intelligent hunters in the oceans. The eight-metre-long assassins have developed a technique specially adapted to this icy environment: a pod of whales works together to create a wave, which then causes a floe to tip over, sending any seal on top into the water. Once there, they are easy game for the orcas.

SPERM WHALE

Sperm whales are the biggest predators on the planet. They can dive to depths of 3,000 metres and hunt giant squid, fish and even crustaceans. The 18-metre hunters can also stay underwater for up to 80 minutes.

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KURT LUTTER.....1933
JOSEF RÖMER.....1934

HELMUTH MYLIUS.....1935

HELMUT HIRSCH.....1936

FRANZ HALDER.....1938
ALEXANDER FOOTE.....1938

MAURICE BAVAUD.....1938
NOEL MASON-MACFARLANE.....1939

JOHANN GEORG ELSER.....1939
ERWIN VON WITZLEBEN.....1940
HENNING VON TRESCKOW.....1943

AXEL VON DEM BUSSCHE.....1944
EWALD HEINRICH VON KLEIST.....1944

CLAUS SCHENK GRAF VON STAUFFENBERG.....1944

The **alternative history** experiment

WHAT IF

HAD BEEN ASSASSINATED?

...would Vienna be a German city?

...would Israel not exist?

...would the Third Reich still be here today?

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WHICH SECRET POWER SAVED HITLER 23 TIMES?

Hitler enjoyed meeting his adoring public more than any other dictator of the 20th century and was often seen mingling with them in a symbolic display of alliance. For some time after his rise to power, getting close enough to touch the Führer was relatively easy – but all attempts to assassinate him failed. In the early years of his rule several lone wolves had designs on his life, but none of their plots were sufficiently well-planned to succeed. Hitler often changed his schedule at short notice or would announce spontaneous visits, which made the task of a would-be assassin exceedingly difficult. When war broke out in 1939, opposition in the Wehrmacht increased and from then on most of Hitler's assailants came from within his inner circle. Security measures were stepped up even more in 1942 when British-trained Czech soldiers assassinated Reinhard Heydrich in Prague. From that point on, only those in the Führer's innermost circle were allowed close contact. Getting hold of explosives also became more difficult, while anyone who did manage it found that Hitler had yet another powerful ally: coincidence…

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Just 13 minutes. That's all that was needed for ten kilograms of explosive to change the course of history forever. Thirteen minutes that, in reality, claim 50 million lives and change the map of Europe. Adolf Hitler suspects nothing when he ends his speech early, shortly before 9pm on 8th November 1939, and makes a hasty exit from the Munich beer hall to the sound of deafening applause. Little does he know that he's missed death by just 13 minutes. With this single, unpredictable action, Hitler has thwarted an assassination attempt that has been months in the making…

DID AN ALLIED ATTACK SAVE HITLER FROM CERTAIN DEATH?

Assassins tried to kill Hitler at least 35 times from 1921 onwards, but despite some meticulous planning, none of the murder attempts succeeded. Often mundane coincidences or a spontaneous change of plans proved to be the Führer's saviour, such as the time explosives packed in liquor bottles failed to detonate on board his plane. On another occasion, Hitler was due to inspect some new army uniforms. The man chosen to model them planned to hide a grenade in his pocket and blow both himself and Hitler up – but the inspection was cancelled because a British bomb destroyed the train carrying the uniforms the night before the event.

Today historians continue to debate what would have happened had an assassin succeeded in killing the Führer. With Hitler gone, would the Nazi regime have built the concentration camps and systematically murdered six million Jews? Would WWII have been shortened or even prevented, saving millions of lives? These kinds of hypothetical scenarios form the basis of counterfactual history. Every assassination attempt marks a fork in the road of history, with many other avenues branching off from the main street.

How might the future have looked, had Hitler been killed? That depends on when each attempt took place. Alongside historians, *Wonderpedia* has analysed several assassination plots and their possible impact during four crucial periods in the Third Reich's development. Each would have exerted wildly different consequences on the course of history…

"Coincidence was Hitler's best bodyguard. Banal subplots make world history."

Writer
Will Berthold

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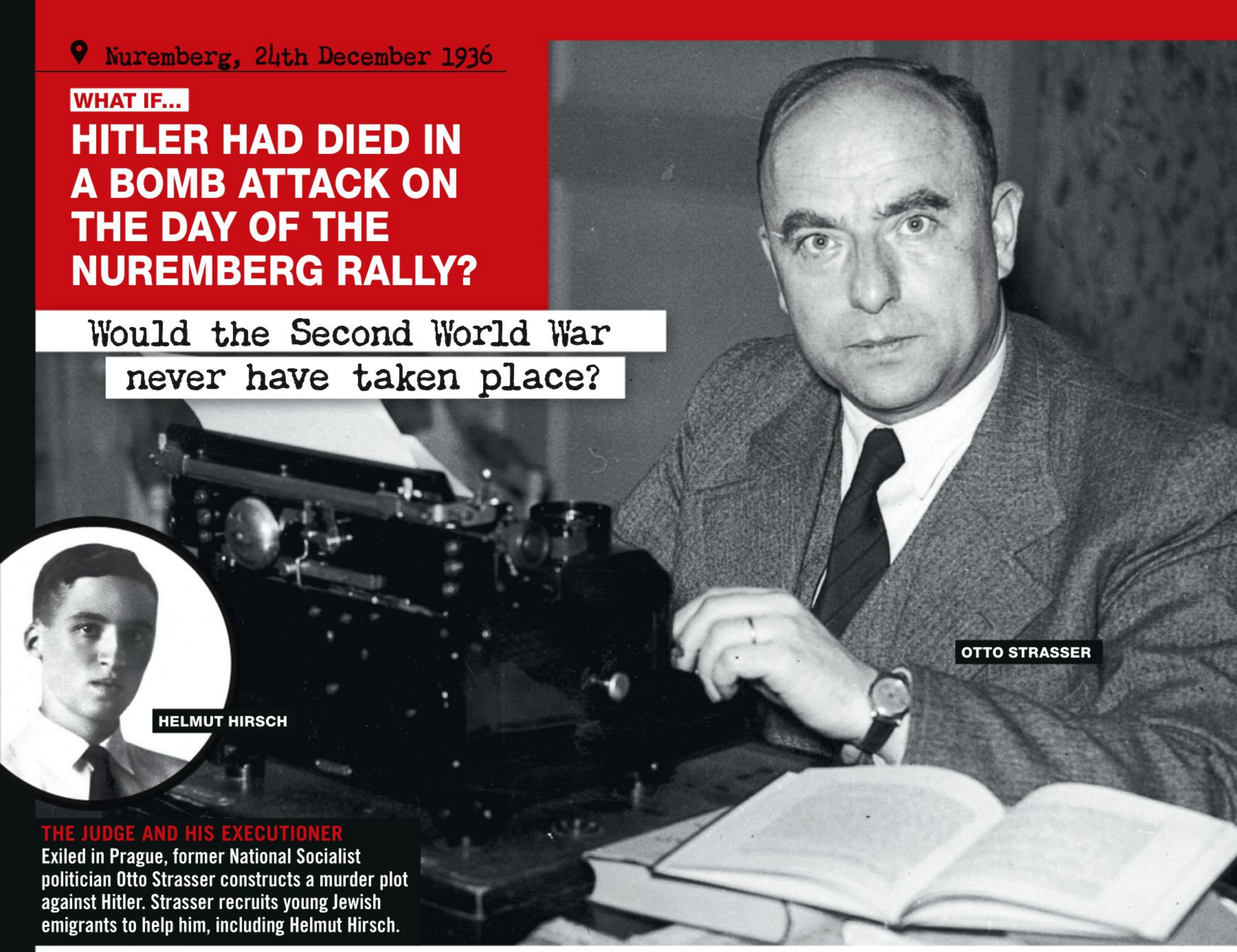
Nuremberg, 24th December 1936

WHAT IF...

HITLER HAD DIED IN A BOMB ATTACK ON THE DAY OF THE NUREMBERG RALLY?

Would the Second World War never have taken place?



THE JUDGE AND HIS EXECUTIONER
Exiled in Prague, former National Socialist politician Otto Strasser constructs a murder plot against Hitler. Strasser recruits young Jewish emigrants to help him, including Helmut Hirsch.

Unusual alliances begin to form after Hitler comes to power on 30th January 1933. In Paris, Vienna and Prague former National Socialists form alliances of convenience with the very people they had railed against so shortly before – Jewish emigrants. They now share the common goal of deposing Adolf Hitler. Politician Otto Strasser is the brains behind one of these murder plots. He is the leader of the newly-formed Black Front, a faction plotting to split the Nazi Party and seize power from Hitler, as well as the brother of Gregor Strasser, a National Socialist politician and rival to Hitler – murdered by the SS during the Night of the Long Knives in 1934. Otto plots his revenge from Prague, raising funds while hunting for volunteers prepared to kill Hitler as soon as an opportunity presents itself.

By 20th December 1936 Strasser has found a willing accomplice in the Jewish student Helmut Hirsch. The young man is tasked with sneaking onto the Nazi Party parade grounds in Nuremberg and placing an explosive device underneath the Führer's podium, timed to detonate during the next Nazi rally. Strasser appears to have

A timeline of assassination attempts

Between 1933 and 1944 there were more than 20 attempts to kill Adolf Hitler. All failed – for a variety of reasons.

4th March 1933
Communist Kurt Lutter and his comrades plan to kill Hitler on the night before the Reichstag elections, but they are betrayed by an informant and quickly arrested.

1933 (date unknown)
Hitler's bodyguards apprehend a suspicious man wearing stormtrooper uniform near the Nazi compound at Berchtesgaden. A loaded pistol is found in his luggage. The man's fate remains unknown.

June 1934
Josef Römer, an organiser for the Communist Party of Germany, studies the layout of the Reich Chancellery for years in order to plan the perfect murder – but shortly before the deed, he is arrested and sent to Dachau.

1935
A group of around 160 men led by publisher Helmuth Mylius infiltrate Hitler's SS security unit in an attempt to kill the Führer. But the Gestapo gets wind of the conspiracy and arrests them.

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thought of everything to ensure that his vision of a massive explosion, powerful enough to kill Hitler and other high-ranking Nazis, becomes a reality.

But what Hirsch doesn't know: German agents have infiltrated the Black Front and the Gestapo is waiting to arrest Hirsch when he re-enters Germany. An informant has made it easy for the authorities to track Hirsch down. Despite international appeals for clemency, the student is sentenced to death and executed on 4th June 1937.

HITLER'S MARCHING SQUARE
Helmut Hirsch was meant to plant a bomb at the Nazi party parade grounds in Nuremberg. This was where the Nuremberg Rallies took place between 1933 and 1938.

If the assassination attempt had succeeded:
Hirsch and Strasser had a clear vision of how the time after Hitler's death would pan out. "Otto Strasser was to take over the party, deactivating the programme and getting rid of the anti-Semitic ideals," says author Will Berthold, who has written a book chronicling some of the failed assassination attempts on Hitler. With Strasser at the helm, the mass murder of six million Jews would have been averted; what's more, the politician also strived for a socialist economic policy and an alliance with the Soviet Union.

However, it remains doubtful as to whether the ex-National Socialist politician would really have been able to bring the party under his control – after all, in 1936, Hitler was at the peak of his popularity and his public backing was high: unemployment had dwindled, salaries were stable, reparations payments had been abandoned and the Treaty of Versailles had been terminated. Hitler's likely successors would have been the more moderate Luftwaffe boss Hermann Göring or the significantly more radical propaganda minister Joseph Goebbels. This throws up the fascinating question of how Nazi Germany might have looked without Hitler.

Experts agree that the war of total destruction that began in 1939 would never have happened and the disastrous Russian campaign would likewise not have taken place. According to historian Alexander Demandt, neither the Supreme Army Command nor the German people shared Hitler's **"panicked fear of the Soviets and his fanatical push to the east."** That would have had consequences for the Nazi leadership: **"If war had been avoided as a result of a military government ruled by its representatives, the Nazi regime would not have lasted in the long term,"** says Demandt. Without Hitler's persuasive charisma and the threat of an external enemy beyond the Third Reich's borders, Hitler's successor wouldn't have had the mandate necessary to rule indefinitely. Internal power struggles would eventually have caused the collapse of the Nazi regime and would have facilitated the formation of a new opposition so that democratic forces would likely have gained the upper hand by the 1960s…

> **"If Hitler had been killed in 1936, he would today be seen as a hero in economic history."**
>
> Former Chancellor of Germany
> **Helmut Schmidt**

May 1935
In Berlin the radical Markwitz Circle (composed of social democrats and unionists) look for recruits prepared to kill or topple Hitler. But the Gestapo slips in a spy and tears the group apart from the inside.

24th December 1936
Supported by Otto Strasser, Jewish student Helmut Hirsch plans to carry out an attack at the Nazi Party's Nuremberg parade grounds. But the young attacker is intercepted before he can do so and is forced to confess by the Gestapo.

Daily Herald

HIMMLER PRODUCES THE "CONFESSION" OF MAN WHO—

PLANTED THE BOMB

2 "BRITISH AGENTS" ARRESTED IN FRONTIER INCIDENT

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BOVRIL WILL SEE US THROUGH AGAIN

GERMANS SINK A JAPANESE LINER

26th November 1937
Josef Thomas, who had just been released from a psychiatric clinic, heads towards the Reichstag in Berlin with a loaded pistol and demands to talk with the Führer. He's stopped just before entering Hitler's office and is handed over to the Gestapo.

Berlin, 28th September 1938

WHAT IF...

HITLER HAD BEEN SHOT IN THE REICH CHANCELLERY?

Would he be revered as a great statesman today?

It is 28th September 1938: a tense silence fills the room, determination is etched in the faces of the conspirators. Heavily armed, they've been sitting at their Berlin quarters for hours, waiting patiently for the signal to strike.

As soon as Hitler gives the order to invade Czechoslovakia, the plotters plan to storm the Reich Chancellery – the Führer's office building in Berlin's Wilhelmstrasse – and eliminate him. In the eyes of the new General Chief of Staff Franz Halder, Hitler's aggressive expansion policies have crossed a line and must be stopped before the situation escalates further. **"Everything was prepared, with a greater chance of success than at any other time,"** according to the historian Joachim Fest.

The opportunity seems more favourable than ever before. Hitler has issued an ultimatum to France and England: either they accept the annexation of Sudetenland (part of the present-day Czech Republic) into the Reich or he will declare war. As most of Hitler's supporters at this time were still against the prospect of war, the chances were that the nation would mobilise for a

FRANZ HALDER

THE CONNIVING GENERAL
On 1st September 1938 Franz Halder was appointed General Chief of Staff of the military. An opponent of Hitler, he quickly forges an alliance with the resistance.

28th September 1938
As the crisis in Sudetenland threatens to escalate, a group of officers led by Chief of Staff Franz Halder resolves to arrest the Führer and overthrow the regime. But Hitler unexpectedly aligns himself with the western powers and foils the planned plot.

Autumn 1938
Bill Philips and Alexander Foote – Englishmen working as spies for the USSR – plan a bomb attack at the Führer's favourite restaurant on Russian orders. But by 1939, following the Nazi-Soviet Non-Aggression Pact, the plans are shelved.

9th November 1938
Swiss theology student Maurice Bavaud plans to shoot Hitler during a memorial march in Munich. The assassination fails, however, because Bavaud is unable to get close enough to Hitler.

20th April 1939
British military attaché Noel Mason-MacFarlane offers to shoot Hitler from the window of his Berlin flat during the Führer's birthday parade, but the British government rejects the plan for the reason that such action would not be 'sportmanslike'.

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coup d'état if Hitler appeared likely to follow up his threats with action. The Führer's demise seemed imminent – until diplomacy, of all things, threw a spanner in the plans of the attackers...

DID A PEACE TREATY PREVENT HITLER'S DEMISE?

The announcement moves through the conspirators' digs like a whirlwind: following Mussolini's intervention, Hitler withdraws his ultimatum and agrees instead to hold a peace conference in Munich. In the resulting treaty, the French and British allow Hitler to retain the Sudetenland and in the process hand Hitler not only his greatest diplomatic success – but also save his life: the war and therefore the assassination planned by Halder and associates is postponed. British Prime Minister Neville Chamberlain proclaims "peace for our time" while the Führer is celebrated by millions of euphoric Germans. The mood among the Wehrmacht also shifts – the resistance collapses. In fact, the very next year, Halder oversees the Nazi invasion of Poland.

But what if the plotters had carried out their plan? The timeline of history would be much altered and Hitler's public image would likely be an entirely different one…

If the assassination attempt had succeeded:

Heads of government would have travelled from all corners of Europe to commemorate the death of Adolf Hitler. Even Stalin and Chamberlain attend the pompous ceremony in Nuremberg to pay their last respects to the Führer, who has died suddenly. There is one last rally with flyovers to the sound of Wagner, and as the crowning farewell, a cathedral of light composed of hundreds of floodlights.

It sounds bizarre from today's perspective, but had Hitler died in 1938, it's likely he would be thought of as a mostly positive leader in the public realm. According to the historian Joachim Fest, this alternative version of history would have seen the dictator go down in history as a **"great German statesman"**. Instead of being infamous for waging war and the Holocaust, he would have been remembered for fostering an economic boom and for his peaceful expansion politics.

Today Austria would still be a German province, with Vienna a city in Germany, and the invasion of Poland would never have taken place. "Without Hitler the situation would not have escalated to world war or to the mass murder of the Jews," says Alexander Demandt. "Although the majority of Jews would still have been driven out, the formation of Israel would never have happened without the Holocaust."

> **"Without Hitler the Holocaust would never have happened."**
>
> Historian **Alexander Demandt**

Instead, as a result of the growing demand for oil, an Arab-friendly policy would have dominated in the west – leading to the creation of the State of Palestine. While the Nazi regime without Hitler would likely have collapsed by the 1960s due to internal power struggles, some historians argue its empire would likely still exist on the same geographical terms today…

NO ESCAPE TO THE HOLY LAND

If Hitler had been assassinated in 1938, the boats carrying Jewish Holocaust survivors to Palestine in 1947 would never have set sail. In fact, the Holocaust would not have taken place at all.

8th November 1939

During a meeting in a Munich beer hall a bomb explodes, killing eight people. Hitler is not one of the victims because he exited the room early (headline, right). The perpetrator, Georg Elser, is caught fleeing across the Swiss border. He is imprisoned and executed in 1945, shortly before the end of the war.

Norddeutsche Ausgabe

VÖLKISCHER BEOBACHTER

Norddeutsche Ausgabe

Chamberlains frommer Wunsch ging nicht in Erfüllung

Die wunderbare Errettung des Führers

Britanniens Ministerpräsident am 3. September: „Ich hoffe bis zu dem Tage zu leben, an dem Hitler vernichtet ist"

Erlebnisbericht aus dem Bürgerbräu

Sie sollen uns kennenlernen!

11th November 1939

German Diplomat Erich Kordt plans to blow up Hitler in the Reich Chancellery. But Georg Elser's botched assassination attempt led to security being beefed up, and Kordt found it impossible to get his hands on any explosive.

Munich, 8th November 1939

WHAT IF...

HITLER HAD LEFT THE BEER HALL 13 MINUTES LATER?

Would the Third Reich still exist today?

Something is not quite right: the crowd are clapping and cheering, but the Führer appears agitated as he enters a Munich beer hall on 8th November 1939 – two months after the outbreak of the Second World War – to hold his annual speech to army veterans.

During the speech the Führer barely pauses to allow for the ecstatic applause of his listeners and ends the talk half an hour earlier than scheduled. Much to the dismay of his supporters, and slap bang in the middle of the national anthem, Hitler rushes out of the hall with Goebbels, Himmler and other Nazi ministers in tow. The time is 9.07pm. Just 13 minutes later a blinding flash illuminates the hall. An ear-splitting bang follows; the force of the explosion causes pillars to collapse and the ceiling to cave in. Eight people die and scores more are seriously injured.

At almost the same time, 125 miles away, a man is arrested in Konstanz on the Swiss border crossing. Border guards find firing pins, wire-cutters, notes about explosives and a map of the beer hall on his person. It's only when

GEORG ELSER

THE LONE WOLF
Carpenter Georg Elser planned the attack on the Munich beer hall for a year. Hitler only survived due to bad weather.

27th June 1940
A group led by Field Marshal Erwin von Witzleben (right) decides to shoot Hitler during a victory parade in Paris. However, Hitler pays the French capital a secret flying visit four days early, thus foiling the plans of the conspirators.

12th October 1940
Three suspects (Karl Hoffmann, Erich Schulz and Wilhelm Tosch) are beheaded for preparing an assassination attempt using explosives at Berlin's Lake Ploetzen. They are thought to have been acting on Otto Strasser's command.

21st May 1941
After Field Marshal Erwin von Witzleben succeeds in persuading Hitler to visit Paris again, he plans to replicate the earlier assassination attempt. But Hitler cancels at the last minute.

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they hear of the events in Munich at midnight that they realise just who has fallen into their hands…

DID BAD WEATHER SAVE THE FÜHRER'S LIFE?

The unique thing about the assassination attempt on 8th November 1939 was this: unlike previous attempts on Hitler's life in 1936, 1938 and even 1944, there were no co-conspirators. Carpenter Georg Elser acted completely of his own volition and came closer to his target than any other would-be assassin both before and after.

What did Hitler have to thank for escaping Elser's meticulously planned attack? The weather. That evening a thick blanket of fog envelops the Bavarian capital, forcing Munich airport to ground all planes. Hitler is forced to take the sleeper train to Berlin – and for that reason finishes his speech half an hour earlier than planned. It's a decision that saves his life.

To this day Elser is revered as the silent hero of the resistance movement – because he acted entirely without political ambition or ideology. He had just one goal: to kill Adolf Hitler – for reasons of conscience and to save Germany. Elser was held as a prisoner for over five years until he was executed at Dachau concentration camp in 1945.

LANDSCAPE OF RUINS
The beer hall the day after the attack: Elser hid the bomb in a weight-bearing column that burst apart during the explosion, causing the ceiling to collapse.

If the assassination attempt had succeeded:

Historians are still divided on the exact consequences of the plot, had it been successful. Hitler's biographer Ian Kershaw believes that his death would not necessarily have had dire consequences for the Nazi empire: **"A successful assassination at this point would probably have strengthened the regime. It's most likely that Hermann Göring would have been appointed as the new Chancellor of the Third Reich. The war would have continued to be fought and Hitler would have been celebrated as a martyr."**

> **"A successful assassination attempt would only have strengthened the regime as Hitler would have been celebrated as a martyr."**
>
> Hitler's biographer **Ian Kershaw**

However, without the encouragement of the Führer, the mass murder of Europe's Jews would likely not have taken place.

However, historian Alexander Demandt proposes an alternative theory in which Elser's attempt represents the last chance to avert the carnage of the Second World War. The Conference of Casablanca in January 1943 – at which Roosevelt, Churchill and Stalin agreed that the war would only end in the event of 'unconditional surrender' by the Axis powers – marks a crucial turning point: **"Before Casablanca, peace with Germany after Hitler's death would still have been possible. The Allies would probably have negotiated with Beck or Rommel."** In the case of a separate peace with the western powers, the Cold War would have begun long before 1947. Germany would have retained its 1937 borders and become a "stronghold against Stalin and the Soviets in the east…"

13th March 1943
Major General Henning von Tresckow (right) smuggles a parcel containing a bomb disguised as two liquor bottles on board Hitler's plane, but the ignition mechanism fails in the unheated cargo area and the dynamite doesn't explode.

21st March 1943
Major General Rudolf-Christoph Freiherr von Gersdorff (right) plans to detonate a device hidden in his pocket during a visit to an armoury. The attempt to kill both himself and Hitler fails because the Führer leaves the weapons depot by a side exit before the bomb explodes.

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East Prussia, 20th July 1944

WHAT IF...

HITLER HAD BEEN KILLED AT THE WOLF'S LAIR?

Would the atom bomb never have been dropped on Japan?

"The briefing has been brought forward by half an hour." This routine communication comes as a severe blow to General Claus Schenk Graf von Stauffenberg – it threatens to thwart his meticulously laid plans. It is the morning of 20th July 1944: Stauffenberg and his adjutant Werner von Haeften have just arrived at the Wolf's Lair in Prussia. Both have a single common aim – they want to kill Adolf Hitler.

Stauffenberg glances nervously at his briefcase, which contains two parcels of explosives, and decides to act. In a side-room off the barracks' main conference room, the men busy themselves with activating the fuse. Their pulses are racing. The briefing begins in 15 minutes and they are running out of time. Suddenly, there's a knock on the door: "The Führer is on his way." There's no time to activate the second bomb. In his rush to get things done, Stauffenberg makes a fatal blunder: he packs only the activated bomb in the briefcase. The second one he leaves behind with von Haeften. Shortly after Stauffenberg places the briefcase under the table at Hitler's feet, he

CLAUS VON STAUFFENBERG

HEAD OF THE ASSASSINS
When General Claus Schenk Graf von Stauffenberg experienced the brutality of the Nazi regime on the frontlines in 1942, he chose to join the resistance movement.

16th December 1943
Major Axel von dem Bussche (right) wants to blow up Hitler with a hand grenade during a uniform inspection, but the suicide attack fails because the parade is called off. The uniforms had been destroyed in an Allied air attack the night before.

11th February 1944
Lieutenant Ewald von Kleist plans to take Bussche's place during the rearranged uniform inspection and to blow up the Führer. This time Colonel Claus Schenk Graf von Stauffenberg provides the dynamite. But Hitler cancels the meeting at the last minute.

11th March 1944
Captain Eberhard von Breitenbuch plans to shoot Hitler at close range during a visit to the Berghof. He also hides a second pistol in his trousers. But the SS bodyguard has been told to only allow generals to get close to Hitler, so the cavalry captain is denied a meeting.

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leaves the wooden barracks. At 12.42pm the bomb explodes. Four people die… but Hitler is not among them.

If the assassination attempt had been successful:

Experts are convinced that even without its fuse, the second bomb would have exploded, doubling the force of the detonation. All of the people in the room would have been killed – including the Führer.

Even in this late phase of the war Hitler's death could have changed the course of history: after all, three million Germans died in the period between Stauffenberg's botched attempt and the end of the war – that's more than in the five years before it. **"Hitler's death would have accelerated Germany's collapse,"** says Alexander Demandt. Cities like Dresden would not have been destroyed to the extent that they were and hundreds of thousands of Jews would have survived. Hitler would not have been able to order the Battle of the Bulge, nor issue the Nero Decree. So what would have happened instead?

WOULD THE IRON CURTAIN HAVE RUN ALONG THE RHINE?

Under the codename Operation Valkyrie, the Wehrmacht takes over the powers of the state within 36 hours. Hitler is deposed and the SS and Gestapo are shut down. The first decision taken by the new government is to begin peace talks with the Allies: with Hitler dead, the conditions of surrender could have been milder than those already formulated at Casablanca in 1943. The war in the Pacific is also ended early and the atom bomb is not dropped on Hiroshima or Nagasaki – saving hundreds of thousands of Japanese lives.

However, it's also possible that Hitler's death would have had the exact opposite effect: Stauffenberg and his accomplices would have been derided by Hitler's supporters as traitors. According to Kershaw: "With Hitler dead, Stauffenberg and his co-plotters would have moved swiftly to take control of the army and to replace the Nazi regime with the government that they had prepared. That their coup would have been successful is by no means certain. Nazi loyalists in the SS and Wehrmacht would undoubtedly have moved to overthrow the government installed by the conspirators, proclaiming the assassination to have been **the most heinous stab in the back imaginable in Germany's struggle against forces determined to destroy the country.** A civil war might have ensued." The Red Army would have used the chaos to advance deep into German territory. **"The Rhine would have formed the Iron Curtain, not the Elbe,"** says Demandt.

> **"With Hitler dead, a civil war might have ensued."**
>
> Hitler's biographer **Ian Kershaw**

For that reason the failed Stauffenberg attempt delivers, like all the other failed attempts, two main lessons: it was mostly luck that repeatedly saved Hitler's life. "Coincidence was Hitler's best bodyguard," is Berthold's view. And the scenarios described show that Hitler's death wouldn't necessarily have brought about a premature end to the war. Only one thing is certain: the world as we know it today would not exist…

NUCLEAR INFERNO
On 6th August 1945 the first atom bomb explodes over Hiroshima and kills 70,000 people in seconds. If Hitler had died in 1944, it's likely these deaths would not have occurred.

PHOTOS: Alamy (4); Getty Images (3); DPA (4); Ullstein; Bundesarchiv (2); Archiv RZB; Corbis; PR (3)

7th July 1944
The unveiling of the new Wehrmacht uniform, which has already been cancelled many times, takes place in Klessheim Castle in Salzburg. Major General Helmuth Stieff is to carry out the assassination but he loses his nerve. For that reason Stauffenberg decides to liquidate Hitler himself.

20th July 1944
Planning to kill Hitler during a meeting, Stauffenberg smuggles two parcels of explosives into the Führer's headquarters inside his briefcase. But the appointment is brought forward, meaning he can only activate one bomb. He leaves the second in a side room with an accomplice – a fatal mistake. The explosion kills four people, but Hitler suffers only minor injuries.

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'The secret pricing algorithms

EXPOSED!

COSTLY TRICKS O

ONLINE RI

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SETAILERS

Why is the time of day and the weather important when shopping online? And how can you save money using a few simple tricks? *Wonderpedia* investigates...

Shortly before Christmas 2015, the price of many products on Amazon fluctuated wildly. For example, at the beginning of December a Samsung telephoto lens for an SLR camera was selling for £849. A few days later it had gone up to £1,199, but on 22nd December the price fell to £1,079, before rising back up to £1,199 on 23rd December. The highlight: a study by price-monitoring service Minderest found that the price of one Nokia camera fell from £1,299 to around £599 in a just few days – a saving of £700!

Camelcamelcamel.com is a price-monitoring site that allows users to track the price of products on Amazon. *Wonderpedia* has been monitoring the Canon Powershot SX710 digital camera; we've seen its >

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price change more than 100 times in the past 12 months, from a high of £357 to a low of £179. It seems pretty clear: the days of fixed-price internet retailers are over.

WHAT'S THE BEST DAY TO BUY TECHNOLOGY?

"We will have to get used to changes in online prices in a similar way to how motorists have adapted to fuel pricing," says economist Michael Fassnacht. In some places prices at the pump can change several times a day. It's the same with airline tickets – the price varies depending on demand, season and time of travel. The system's called 'dynamic pricing' and it's a weapon being used by more and more companies looking to dominate the internet marketplace.

Online retailing is undergoing its biggest upheaval since the dawn of the internet. In the early days firms like Amazon and Ocado focused on market share, investing heavily in marketing and state-of-the art technology. Latterly, fashion retailer Zalando has tried something similar. Popular overseas, it spent millions on its UK launch in 2011 in an attempt to make users familiar with its brand and website. But that's all changing – now it wants to make money.

To help maximise revenues, retailers are using a resource they have collected over the years – one that we've willingly handed over: our data. Dynamic pricing is basically an algorithm, a model that can be tweaked to suit individual retailers' needs. It's a program into which millions of customers' details have been fed, alongside details of competitors' prices – even things like the time of day and weather are included. The algorithm calculates the optimum price that a product can be sold at: low enough to attract customers – but high enough to make a profit. If the data shows that men buy a lot of electronic devices at 9pm on rainy Wednesday nights, the retailers will change their prices at that time. Why do men buy at that time? Who knows? The retailers certainly don't – and neither do they care. The only important things are the statistical calculations, the sales and the profit. And here nothing is left to chance: only popular products decrease in price, others become more expensive.

An example: if, with the help of our data, Amazon determines that a particular TV is currently very popular, it can lower its prices at any given time to undercut the competition. Customers buy the TV from Amazon – but before paying they are recommended an HDMI cable to go with it. The trick: the cable is actually dearer than from other dealers. But because it's only a cable and the TV was a bargain, the customer buys it. And because this works with almost all accessories, Amazon changes the price of up to 20% of its products – every single day.

DO IPHONE USERS PAY MORE ONLINE THAN ANDROID USERS?

By using price comparison sites, customers have long believed that they hold power over web retailers. But companies now want to shatter this online transparency: when providers' prices constantly change, the comparison sites are overwhelmed – and the customer loses sight of the 'right' price.

Retailers can even use their data to set prices on an individual basis, since an IP address reveals if a shopper is living in a rich city or a poorer part of the country. So are prices higher for city dwellers? So far, there's no evidence of this – but, technically, it's possible. As for shopping using your smartphone, is it more expensive for iPhone users than those with an Android device? Maybe not here in the UK – but an experiment in Germany found that a white iPhone 6s 64GB on Amazon.de was priced €7 dearer when looked at using an iPhone. "It's a popular assumption that Apple users have a higher income," says Fassnacht. "It may be that internet retailers are pricing things accordingly." So in principle, it's possible for retailers to set individually tailored prices that take into account a shopper's location, salary and needs. It would be legal too – there's no law stating a one-price-fits-all model must apply.

As for traditional bricks-and-mortar shops, they're watching with interest. It surely can't be long before dynamic pricing hits the high street too…

THE SINISTER POWER OF COOKIES

The retailers' goal? To make the customer the right offer, at the right time, at the right price. 'Cookies' are helping them do just that. Search for a specific trainer on the web, and next time you log on chances are you'll see adverts for athletics gear on your screen. It's as if retailers are taking notes on their customers. In a way, that's exactly what they're doing. Each time you visit a webpage, small information files known as cookies are sent from the website to your browser. Every time you go back to the same site, the browser retrieves the cookie and sends it to the website's server. Thus the retailer will already know who you are – and which products you'll be interested in…

INTERNET GIANT
Amazon operates eight warehouses (known as 'Fulfilment Centres') in the UK.

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10 QUESTIONS AND ANSWERS ABOUT **ONLINE SHOPPING**

1. CAN I HAGGLE?

Just bought something and suddenly found a cheaper deal on a different website? Then try complaining to the retailer – a short email will suffice. If the retailer offered a 'best price guarantee' you're in luck as the smallprint will show that they have to match the other price. If no such guarantee was offered, the retailer may still subtract the difference as a gesture of goodwill – particularly if you have shopped there before.

2. HOW CAN I LOWER THE PRICE ?

Many online shops offer vouchers that can save you 10-20%. It's even worth typing the website's name along with the word "voucher" into a search engine. You enter the voucher code at the checkout immediately prior to paying. And if a product you want has been in your basket for a few days, the retailer may even offer you a discount under its own initiative.

3. CAN I SAVE ON REPEAT PURCHASES?

Yes – particularly on household essentials. If you can predict when you'll need more coffee, razors, etc try using Amazon's 'Subscribe' feature to automate the repurchasing process. Not only will it save you time in the future (and decrease the risk you'll be stuck with an unwanted beard), you'll also get a better price than if you were to buy them on a one-off basis.

4. WHAT'S GOING ON WITH LAST-MINUTE OFFERS?

"Ten people are looking at this product!"; "Only three items left!" Retailers use messages like these to urge the customer to buy as quickly as possible. However, you should never buy under pressure. This is especially true with holiday packages – it's often far cheaper to put the elements together yourself. Contrary to what they would have you believe, the best hotel room rates are not always available through third parties, while hotels themselves often reserve their best rooms – and room upgrades – for those customers booking direct.

5. HOW CAN I SAVE ON SHIPPING?

Many stores offer free shipping to customers who spend a certain amount. If you're falling short of that minimum, think about other items you may need that you can purchase ahead of time. This is especially useful around Christmas.

6. CAN I RELY ON REVIEWS?

Be careful: up to 30% of all customer reviews of products are fake. Some online retailers such as Amazon flag up feedback from customers who have actually bought the product as "verified". You can usually trust these.

7. DO I NEED TO READ THE SMALL PRINT?

Skimming past the terms and conditions can prove to be very expensive. For example, cheap car hire deals can also come packaged with high excesses. Write the car off, and in extreme circumstances you could end up paying for a new one.

8. WHAT'S THE BEST DAY TO BUY AN AIRLINE TICKET?

The old adage that buying a flight on a Tuesday would save you money is now a thing of the past. The Airlines Reporting Corporation studied hundreds of millions of tickets bought around the world last year to see the new trends. Their conclusion? There is no longer a 'best' day. Tuesdays are no cheaper than other days, but flights become markedly more expensive when booked on a Friday.

9. WHAT DOES MY PHONE SAY ABOUT MY INCOME?

Did you know that online retailers can find out what device and browser you're using when visiting their sites? That means it's possible that iPhone users will be shown a higher price: rightly or wrongly, some retailers assume that customers with Apple products have more disposable income – or at least spend more of it. If you want to see if this is happening to you, try visiting a website using more than one device.

10. CAN I OUTWIT DYNAMIC PRICING?

You may be able to beat the retailers at their own game. Follow these tips: 1. Clear your browsing history and cookies. 2. Log out of all social media accounts. 3. Switch to private browsing. Good luck!

PHOTOS: Shutterstock; Fotolia; DPA; PR (3)

MORE POWERFUL THAN RELIGION?
Islamic State is known to distribute Captagon tablets among its fighters. Many IS fighters end up addicted to the drug – despite this clearly contradicting the teachings of the Qur'an.

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CAPTAGON:

ISLAMIC STATE'S DRUG OF CHOICE

It turns ordinary fighters into super-soldiers, and normal people into emotionless killers. In the Middle East a tiny pill is inflaming the situation in Syria still further – while at the same time aiding IS in its most brutal crimes

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Each pill is about the same size as your average headache tablet. But hardly anyone swallows them. Instead, Captagon tablets are ground down to a powder and divided into three or four lines. The jihadists pass then around a tube and snort the powder up their nostrils. In split seconds the drug bypasses the blood-brain barrier and floods the central nervous system like a tsunami. Dopamine accumulates in the frontal lobe of the brain and enhances the user's concentration. Noradrenaline is released, leading to an increase in blood pressure. The whole body is now functioning on high alert, as it would be if threatened – simulating the fight or flight reaction. Hunger, tiredness and pain disappear. Feelings of fear also fade away – including the fear of one's own death. Was this what drove the IS jihadists who took part in the Paris attacks last November?

FROM PARTY PILL TO WARMONGERS' DRUG

Eyewitness reports attest to the emotionless expressions worn by the Paris attackers as they went about their massacre – "like zombies" according to one onlooker – as if stupefied by drugs. Could that explain in part why young men in suicide vests sent so many innocent people to their deaths? French police certainly think so; a stash of syringes and tubing found in an apartment

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rented by the jihadists seems to indicate they'd taken Captagon prior to the attacks. But what kind of drug turns someone into a killer? Captagon is a brand name for the drug fenethylline, an amphetamine derivative modified so that it could be sold as a pharmaceutical drug. And that is exactly what has been happening for 25 years.

Developed in Germany in 1961, Captagon was used to treat conditions such as hyperactivity and depression. However, most sales came from students, partygoers and athletes keen to use the drug as a stimulant. In 1986 Captagon was classified as a dangerous drug and banned.

It may have been prohibited, but it never disappeared: in Europe Captagon gradually faded into oblivion, but the illegal amphetamine derivative only grew in popularity in the Middle East. In states like Yemen and Saudi Arabia, where alcohol is illegal, both adult professionals and young >

Some IS fighters take so many pills, if you shoot them, they won't drop.

SYRIAN REBEL

DESECRATORS OF THE QUR'AN
Although intoxicating substances are completely forbidden in Islam, IS permits its fighters to take Captagon. The drugs serve a higher purpose, say the terrorists. But IS is just the dealer…

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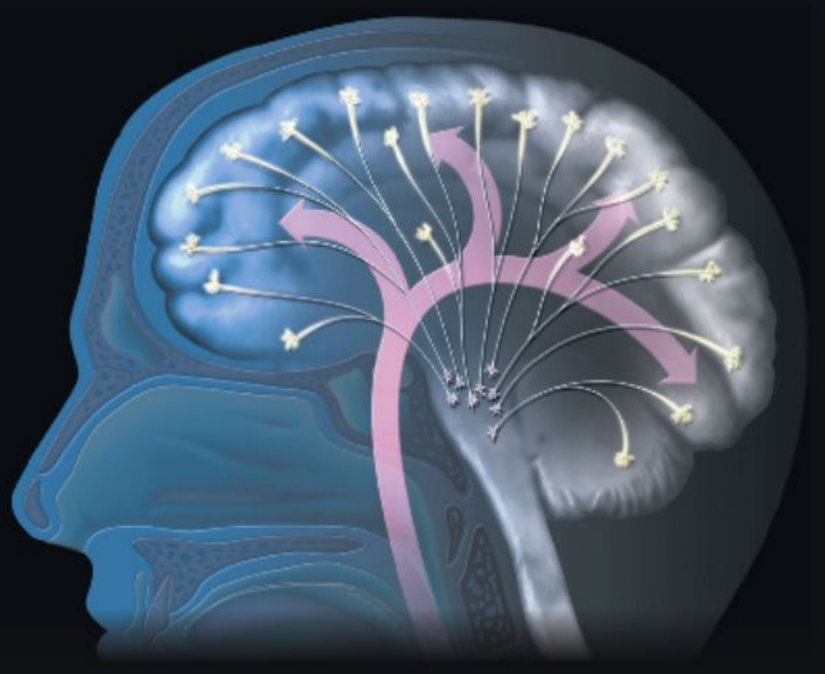
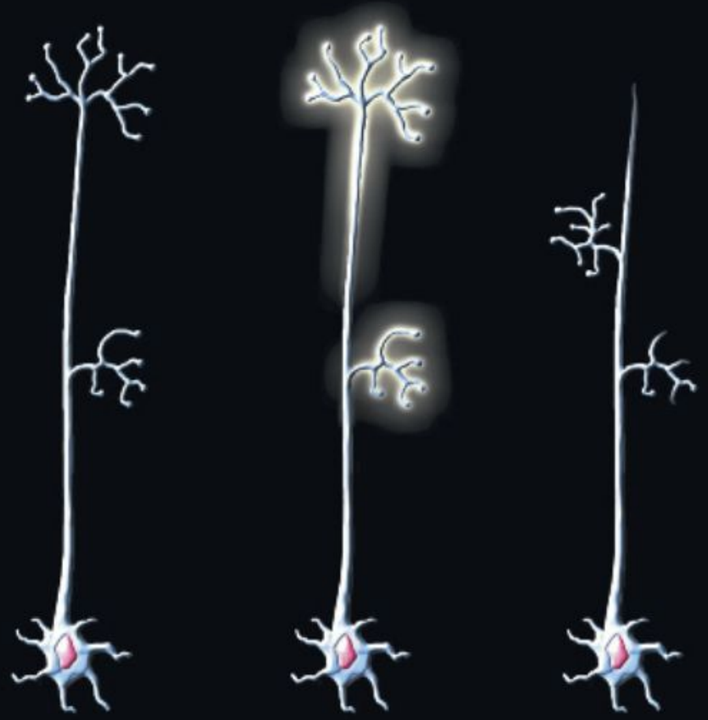
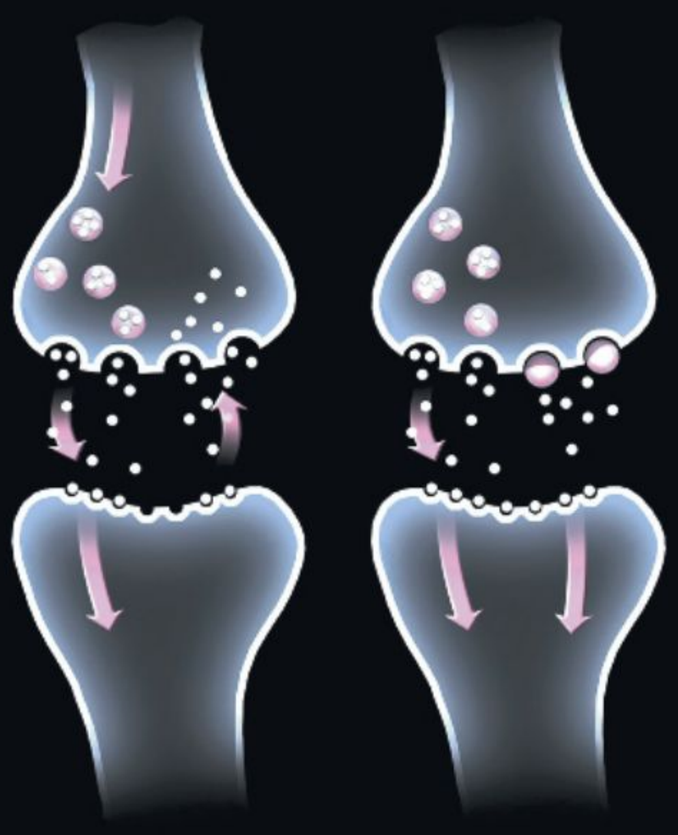
STIMULATED
Almost all of the fighters taking part in the Syrian civil war take Captagon to overcome fear and enhance their abilities.



INUNDATED
As the body begins to break down Captagon into its two constituent parts, large quantities of the brain's messenger substances dopamine and noradrenaline are released.



UNDER CONSTANT ATTACK
The fenethylline contained in the Captagon docks onto the body's nervous system. It forces nerve cells to mass produce these two neurotransmitters (dopamine and noradrenaline).



SYNAPTIC FIREWORKS
Because the drug also prevents the breakdown of neurotransmitters, the exchange of information between the synapses is strengthened.

HOW CAPTAGON WORKS IN THE BODY

Captagon initially affects the body in the same way as other amphetamines such as speed or ecstasy: the brain operates at full blast. The synapses release more neurotransmitters while the drug simultaneously prevents the breakdown of these messenger substances. The brain is swamped.

Different types of amphetamine vary in the amount of transmitters that are released. Ecstasy, for example, causes lots more serotonin to be distributed, leading to an increased feeling of happiness. Captagon, on the other hand, concentrates on two other messenger substances: noradrenaline (which leads to enhanced performance) and dopamine (which increases concentration and self-awareness). The combination turns simple fighters into alleged super-soldiers – at least for as long as the drug is active. The problem: Captagon exploits the body's energy reserves to such an extent that the user then needs more Captagon to stay fit. But the more a person takes, the more severe the change in personality, leading to the breakdown of their own sense of self. Allied to this, every tablet taken increases the risk of a heart attack or stroke.

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people use the tiny pills as a recreational stimulant – although to do so is to risk draconian punishments like flogging.

Since civil war broke out in Syria in 2011, Captagon has experienced something of a renaissance. “More Captagon is being produced now than ever before,” says General Ghassan Chamseddine, head of Lebanon’s drug enforcement unit. “Most of it is made in Syria, and then smuggled to Lebanon and exported to the Gulf area.”

Authorities recently uncovered a haul of 50 million Captagon tablets – their biggest find to date. Their value? Roughly $300 million. In Saudi Arabia the street value of a single pill is about $20, but in Syria packets of 200 pills are hawked for just $65. “Manufacturing the drug is child’s play,” explains one Syrian drug-maker, who wished to remain anonymous. “Most of the ingredients, like caffeine and vitamins, are easy to get hold of in Turkey and they aren’t illegal per se. It’s only the amphetamines that are more difficult to obtain. And to make the pills all you need is a chocolate coating machine, the same kind used to make smarties.”

If somebody takes 30 pills they become paranoid and violent – they are completely devoid of fear!

SYRIAN CAPTAGON MAKER

THE DRUGS’ FINAL STOP
When the authorities seize Captagon, the pills are burned in ovens like these ones here in Yemen.

THE FUEL OF ISLAMIC STATE

As Syria has degenerated into a failed state, nobody in the country is bothered about the number of homemade ‘drug kitchens’ that have sprung up. Most of their customer base is involved in the civil war: soldiers fighting on the side of Bashar al-Assad, militants waging war against the dictator – and, above all, Islamic State militants. “Everything that IS does is because of this pill,” says the drug-maker, who also sells directly to the group. “They’ll have a thirst for fighting and killing and will shoot at whatever they see. Suicide attackers, in particular, take dozens of the pills to prepare themselves.” Not for nothing is Captagon now seen as a “jihadist drug” in the >

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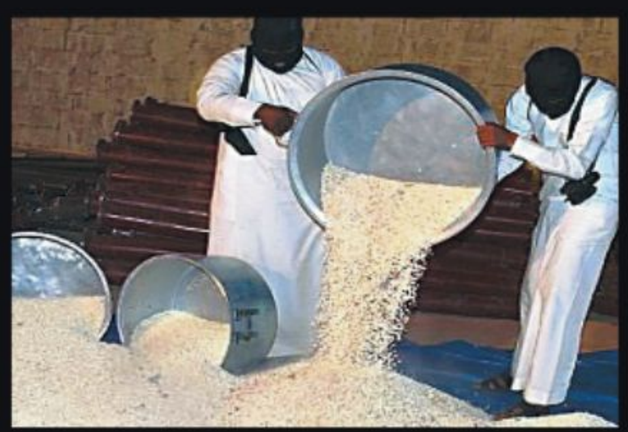
HOW DOES THE CAPTAGON TRADE IN THE MIDDLE EAST WORK?

The illicit trade in Captagon was brought into being by a European intelligence agency: the Bulgarian Committee for State Security (CSS). During the Cold War the CSS smuggled Captagon to the Middle East in order to improve the state of the national coffers. After the collapse of the Eastern Bloc, this smuggling process was privatised – by an ordinary drugs mafia. For years Bulgaria supplied Arabic nations via Turkish smuggling routes.

Then, in the 2000s, Lebanon became involved through the terror group Hezbollah. Its leaders in the Bekaa Valley built the world's biggest Captagon production plant and began manufacturing and distributing the drug. Today Lebanon is just the trading hub. The drug is now produced in Syria, where numerous drug-making factories have sprung up since the breakdown of law and order. Production satisfies the demands of the army, militias and IS.



PILL TSUNAMI
Saudi Arabian authorities released this picture of a Captagon seizure in Riyadh. It constitutes just a fraction of the pills smuggled into the country.

CAPTAGON ROUTES
Almost the entire Middle East is supplied with Captagon produced in Syria. The main trading hub is in Lebanon.

Middle East. Indeed, the drug helps users overcome their inhibitions about killing more easily. The amphetamine derivative enhances the user's strength and urge to attack. "You're suddenly wide awake: you wouldn't be able to close your eyes even if you wanted to," says a masked jihadist in one video online. "You feel invincible – even if ten enemies are standing in front of you, you're certain that you can kill every last one of them."

With long term use the drug even leads to personality changes in those taking it. "If a person uses Captagon at very high doses for a long period of time, they will begin to develop psychoses and display excessively violent tendencies," says Dr Richard Rawson, a psychiatry professor at the University of California in Los Angeles. "It's exactly the kind of drug you wouldn't want a group of terrorists to get their hands on."

But this warning has come far too late: IS's very existence is bound up in Captagon. The reason: for some followers the drug is more powerful than the Qur'an – or at least IS's version of the holy scripture. In reality the terrorists are afraid that their supporters will desert them – due to their anti-Islamic crimes, the killing of innocent people, barbaric torture methods, the encouragement of rape. Using Captagon the terrorists are able to keep their members in line by making them dependent on them – as they would be on a conventional dealer. And the risk of becoming addicted to Captagon is huge. After just a few hits a user can already be completely under the drug's spell. For the leadership of IS that is a stroke of luck; they no longer need to convince these members of their twisted ideology and faith – they just make sure their supplies of Captagon are constantly replenished…

PHOTOS: DPA (2); Getty Images; Corbis; PR (2). ILLUSTRATIONS: SPL/Agentur Focus; PR

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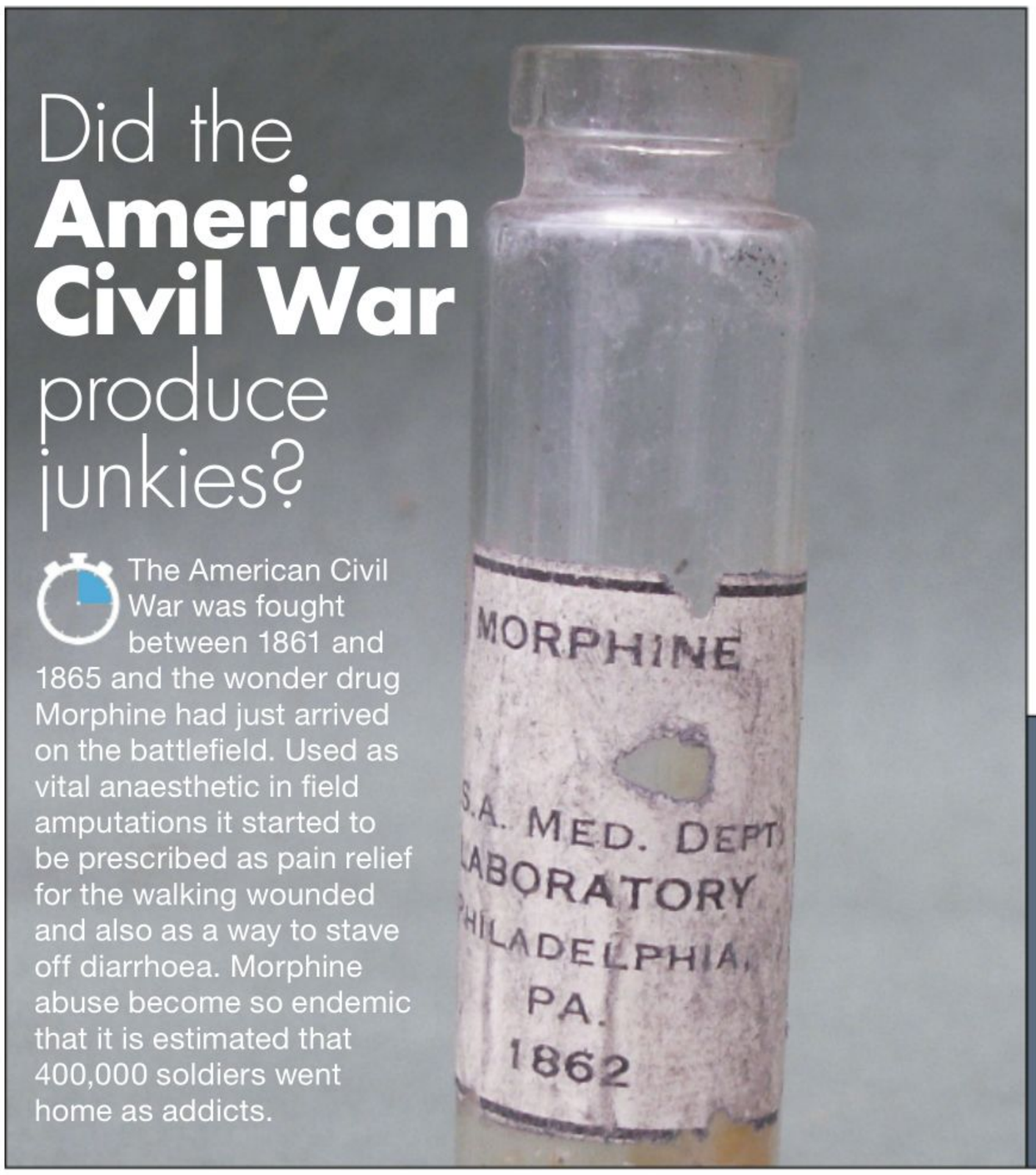
[SMARTER IN 60 SECONDS]

4 FASCINATING QUESTIONS ABOUT DRUGS AND WARFARE

Did the **American Civil War** produce junkies?



The American Civil War was fought between 1861 and 1865 and the wonder drug Morphine had just arrived on the battlefield. Used as vital anaesthetic in field amputations it started to be prescribed as pain relief for the walking wounded and also as a way to stave off diarrhoea. Morphine abuse become so endemic that it is estimated that 400,000 soldiers went home as addicts.

Were the Napoleonic Wars **fought drunk?**

As Europe was plunged into a series of bloody conflicts that raged from 1803 to 1815, British troops were being encouraged to indulge in a tipple or two in order to boost morale and guard against disease. So popular was this unofficial standing order that some soldiers were known to spend a month's wages on booze while teetotallers were reviled as 'Methodists'.

Was World War Two fuelled by speed?

By the time that World War II reached its height in 1941, it was a fully mechanised war. But while machines don't need to sleep, the human operators do. War chiefs found a way round this problem by issuing small blue pills – amphetamines – that kept the men awake and alert. Soldiers on both sides were using speed with alacrity, with the Americans distributing around 200 million pills and German tank crews wired to the eyeballs on 'Panzerschokolade' (crystal meth).

How did the warlords control **Sierra Leone's boy soldiers?**

War is hell, but there's something particularly hellish about a war fought by kids who are barely bigger than the guns they carry. Sierra Leone's civil war, a conflict that raged between 1991 and 2002, relied on these boy soldiers who were driven to fight by chemical means. The substances forced upon them include amphetamines, cocaine and a drug called 'brown brown' – a mixture of cocaine and gunpowder rubbed into cuts made on a child's temple and covered with tape.

PHOTOS: Alamy, Expertissim; PR

They shape Europe's forests like no other animal, discovering food where others have long gone hungry. Because only they know that the real treasure of the woods is found deep beneath the snow...

WHERE THE WILD BOAR ROA

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3 MONTHS, 3 WEEKS, 3 DAYS...

That's how long it takes for a litter of young boar to see the light of day. Newborn boar are susceptible to the cold as they are unable to regulate their body temperature. So, to protect them, the sow builds a shelter from fir sprigs. In ideal circumstances this will be south-facing so that it receives plenty of sun.

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PEST CONTROL

Few things will remain after a wild boar has been burrowing in the soil. The animals dig around, wiping out many living organisms up to half a metre below the surface in the process. But it's not all bad: their rooting helps aerate the soil and the boars actually do us a favour by eating pests like cockchafer grubs, which can destroy entire potato harvests. One wild boar was recently found to have 1,900 pupae of the species in its stomach.

ACORNS
90% of the boars' diet is vegetation – mainly acorns.

MICE
Wild boar only hunt on occasion – mostly for small mammals like mice.

EARTHWORMS
Young boar need animal protein – they're partial to a few earthworms!

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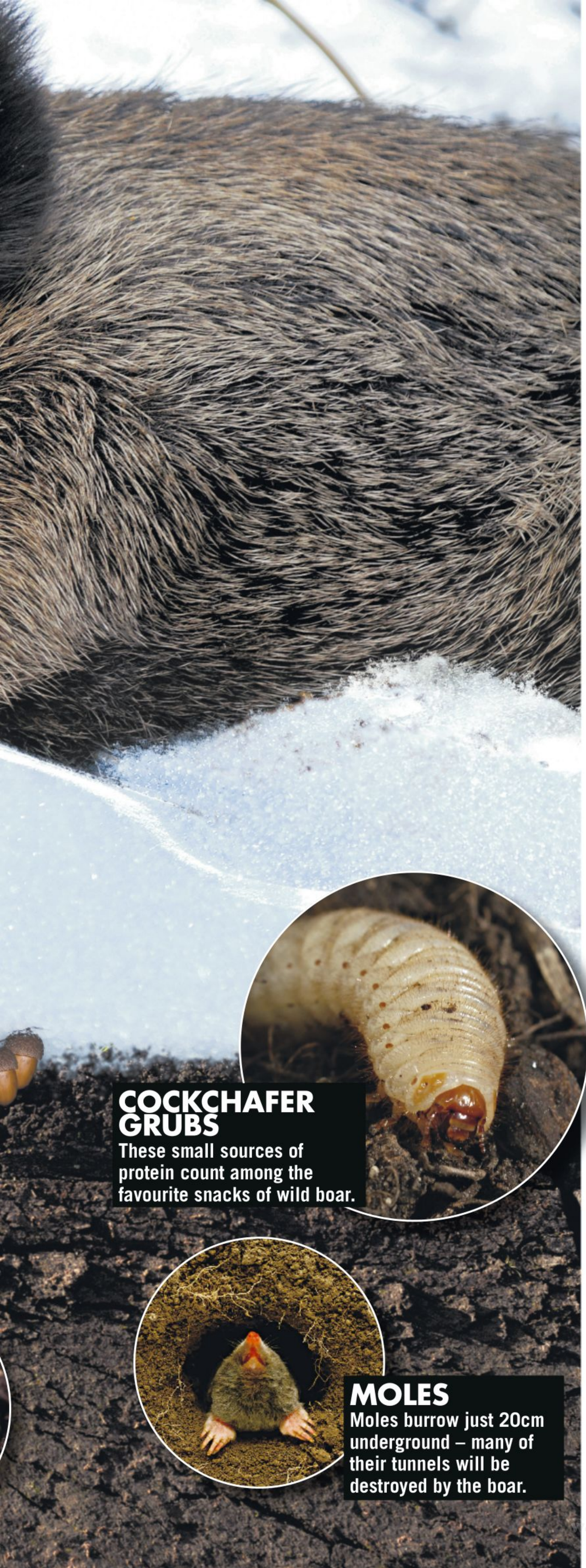

COCKCHAFER GRUBS
These small sources of protein count among the favourite snacks of wild boar.

MOLES
Moles burrow just 20cm underground – many of their tunnels will be destroyed by the boar.

A winter forest in the heart of Europe: a 30cm layer of snow covers the clearing. A light breeze shakes tiny snowflakes from the branches. It is completely silent, only the tapping of a great spotted woodpecker can be heard in the distance – until THEY arrive. With a cursory grunt the lead sow trots into the clearing, circling a few times as if to check the surroundings, and grunts again. At this signal four more sows, five young pigs and ten piglets follow. Two males clatter through the undergrowth at a distance, both eyeing the sow sprawled flat out on the virgin snow surrounded by the rest of the clan.

Welcome to the empire of the wild boar! Thanks to an astonishing level of intelligence, a body built to last and a good helping of courage (or brashness, depending on how you see it), the wild boar has become one of the most successful mammals in Europe. To understand the wonderful world of *Sus scrofa*, it's useful to know a few specialist words that have their origins with ancient groups of hunters. Female wild boar are known as sows, the males hogs and the smallest members of the family are called piglets. When wild boar get together in a group, they aren't known as a pack or a herd, but a sounder. As for the season when wild boars mate? Well, actually there isn't a term for that, but such is the enthusiasm with which the males seek out the females it might as well be termed a frenzy. This frenzy normally begins in December and lasts until January. In the forest clearing, therefore, two battles are simultaneously playing out: one over food and one over breeding.

HOW DO WILD BOAR FIND FOOD?

In the winter forest wild boar find a richly laid table, one that's usually covered by a tablecloth of snow. The sows waste no time in getting down to work: living things that burrow into the earth to seek shelter from the cold or to wait out their chrysalis stage, as well as food reserves stashed here by other wild animals, are mercilessly dug up. No surprise there: a wild boar's nose is 2,000 times more sensitive than ours, and it's not just equipped with a phenomenal smelling ability: its delicate sense of touch can also accurately detect whether it is dealing with a stone or a tasty snail, or even a tiny piece of grain. Thanks to its unique constitution the stomach of a wild boar can cope with almost anything: insect larvae such as cockchafer grubs, snails, worms, mice, moles, roots, potatoes, acorns… wild boar won't even turn their noses up at rotting carcasses. But how do they get their meals out of the frozen soil? Well, by using a cunning – and very simple – plan…

Wild boar are among the **most successful** mammals in Europe

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First, they melt the snow: huddling together on the ground, the sounder use their combined body heat like a giant radiator to defrost the snow. Next, they thaw the ground: by staying put a little longer, the boar start to warm the frozen larder beneath the earth. Then, using the ingenious sow's own cutlery, the process of 'breaking' will begin. A combination of extremely strong muscles at the tip of its snout helps the mouth and teeth to function like a sophisticated digger, shovelling earth as they root around in the soil.

Using their canines – in mature males these can grow up to 30cm long – the wild boar burrow into the earth. Also known as tusks, the canines continue to grow over the course of their lifetime. With them, wild boar can dig deep enough to lever even the most stable wire fences from the ground: a sounder of 20 animals can ruin an entire field like this in the space of a single night. Devastating for agriculture, but a blessing for foresters as the animals can also do the same to less fertile areas of land. As the wild boar root around, the upper layer of soil is mixed with layers deeper down. Aerating the soil like this means that nutrients are more widely distributed – creating optimal conditions for new germ buds. In fact, in forests frequented by wild boar, there are three to four times more saplings than in comparable wooded areas without the species.

HOW DO HOGS WIN OVER SOWS?

While the sounder in the snow-covered clearing do their bit for forest conservation, the two males focus their attention elsewhere. On the sow, to be precise. Because

HEAD START

At birth the piglets weigh less than a hundred grams – but by the time they reach 8-10 months they'll weigh between 20 and 30kg and have reached sexual maturity.

TAKE UP ARMS!

The canines of a male wild boar can grow to be up to 30cm long – they serve as a way to appear assertive…

REBELLIOUS YEARS

Male wild boar – known as hogs – must leave the matriarchy when they reach the age of one and a half. Solitary animals, they trudge alone through the undergrowth – unless it's mating season.

it's mating season and each hog is desperate to breed with her, the battle lines are soon drawn. Act I of the pending fight: showing off. The hogs gnash their teeth together and paw the ground with their hind legs. Using their tusks the males drool a salty, pheromone-packed foamy saliva from their mouths. The more foam a hog secretes, the more attractive it is to the sow. Nature plays a clever part in this salivary display: foam's large, frothy surface area means it can contain a lot of pheromones.

If the foam doesn't quite get the job done, Act II begins: jostling. And nobody does that as well as a hog! Each male tries to ram their canines into the side of the other. So that the pair are not seriously injured in the process, nature has taken precautions and equipped their sides and shoulders with a shield of sorts – the connective tissue here is several centimetres thicker than on the rest of the body. However, on occasion, the hogs can still inflict serious injuries on each other.

When one of the pair finally backs down, the winner triumphantly marks their newly-won territory with a layer of pheromone foam. During a walk through the forest, therefore, the following applies: if you see foam on the branches and in the bushes, and if it has a suspiciously strong umami whiff to it, then it's likely a randy male is in the vicinity. But beware: in Europe the wild boar no longer has any natural enemies and no game in our forests here in the UK could go toe to toe with it. It will normally steer clear of humans – unless it feels threatened, wounded or angry! Running at almost 30mph, the 80kg animal can achieve the impact force of a rhino sitting on the bonnet of a car – about 1,500kg.

A wild boar's nose is **2000 times** more sensitive than a human's

DO WILD BOAR EXIST IN THE UK TOO?

A few years ago in Switzerland wild boar even managed to throw the engine of a regional train off the railways tracks. "If you find yourself in the animal's path, run," advises one experienced driver, who uses his train's horn to scare away any lurking boar. Or at least he tries to, because they're far too clever to fall for this blatantly obvious trick.

What's more, the animals are in finer fettle now than they have been for years: an abundant supply of maize and particularly good stocks of acorns and beechnuts in Europe allow *Sus scrofa* to reproduce twice a year. Sows are usually well-nourished enough to birth up to seven piglets every six to ten months, and these youngsters will reach sexual maturity when they're around eight to ten months old. After all, unlike most mammals, the time at which they're able to reproduce is dependent on their weight, not their age.

Up to two million of these fascinating animals roam Europe's forests, but they're not entirely unknown here. Around 1,000 are believed to call the UK home, mainly in areas of Kent, East Sussex and Gloucestershire.

PHOTOS: Fotolia; Ardea (3); Zoonar; Corbis; Getty Images (2); I-Stock; Imago; PR

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[QUESTIONS & ANSWERS]

JETPACK POWER

The wingsuits that Yves Rossy and Vince Reffet use to glide over Dubai are equipped with four kerosene-operated jet engines. These can accelerate the suit to up to 200mph.

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CAN YOU FOLLOW A JET WITH A WINGSUIT?

The pair leap out of the helicopter at a height of 1,670 metres and embark on one of the most daring stunts of all time: high above the skyline of Dubai, Yves Rossy and Vince Reffet begin to follow the world's biggest passenger jet, an Airbus A380. Known as 'jetmen', each of the extreme sportsmen wears a 55kg Kevlar wingsuit with a two-metre wingspan. At a speed of almost 200mph, Rossy and Reffet approach the aeroplane until they're just metres away – one false move here could cause the men to go into a tailspin and smash the plane to pieces. But the manoeuvre succeeds. After several minutes the jetmen veer off and use their parachutes to land safely on the ground. Rossy developed the jet-powered wingsuit system himself and has already used it to cross the Alps and the Grand Canyon. "My dream was to fly as free as a bird – and now I have achieved this," says the daredevil.

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1,000

hairs per square millimetre make up an otter's fur. This makes it one of the thickest coats in the animal kingdom.

HOW LONG CAN AN OTTER STAY UNDER WATER?

Otters, such as this European otter, are skilful divers, capable of staying underwater for up to eight minutes. How can the marine mammals stay submerged for so long? Well, it's all thanks to oxygen-binding proteins in their muscles that allow the animals to store reserves of oxygen in their bodies. This makes it possible for them to dive for long stretches of time without returning to the surface to breathe. While diving they also close their small ears and nostrils to prevent water rushing in. This member of the weasel family spends most of its life in the water, only stepping onto land in winter if their stretch of river freezes over. Sea otters don't even leave the water to sleep – instead they wrap themselves in seaweed to stop themselves drifting away.

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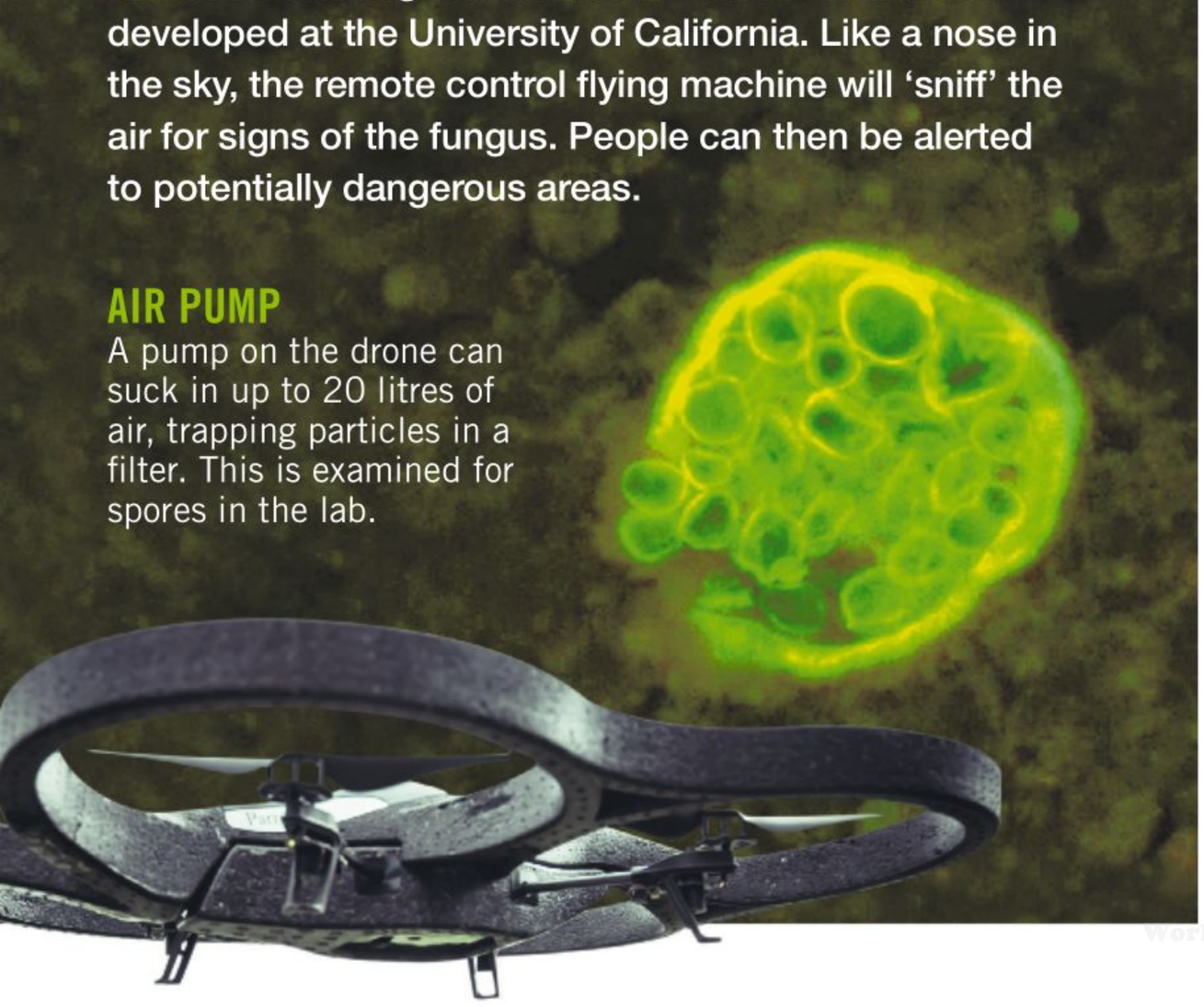
DO MITES KNOW WHERE I HAVE LIVED?

Their tiny 0.3mm size belies the depth of their knowledge: hair follicle mites (left) know more about us than you think. With the help of these tiny organisms in our hair, scientists can draw reliable conclusions about a person's geographical origin. A research team at Florida University analysed samples from a variety of hair follicle mites and confirmed that the genome of the Arachnida-class mites differs depending on the geographical ancestry of their human host. The mites in the hair of people with European roots displayed different genetic traits to humans with Asian and Latin American heritage. The mites' worldwide distribution may even reflect how humans have migrated and evolved over the course of history.

Can a drone prevent an epidemic?

It spreads unnoticed through the air we breathe and causes a flu-like condition called valley fever: inhaling just a single spore of the Coccidioides fungus can cause severe chest pains, sometimes even death. Now the threat is being hunted down – thanks to a drone developed at the University of California. Like a nose in the sky, the remote control flying machine will 'sniff' the air for signs of the fungus. People can then be alerted to potentially dangerous areas.

AIR PUMP
A pump on the drone can suck in up to 20 litres of air, trapping particles in a filter. This is examined for spores in the lab.



HOW MANY COUNTRIES SEPARATE NORWAY AND NORTH KOREA?

More than 4,500 miles separate Norway and North Korea (both marked in blue) and yet only one country stands between their two borders: Russia (yellow). An overland journey spanning the capital cities Oslo and Pyongyang would cross eight international time zones and take several weeks to complete. Finland and North Korea are also bisected only by Russia in the same way, although there is one less time zone between them.

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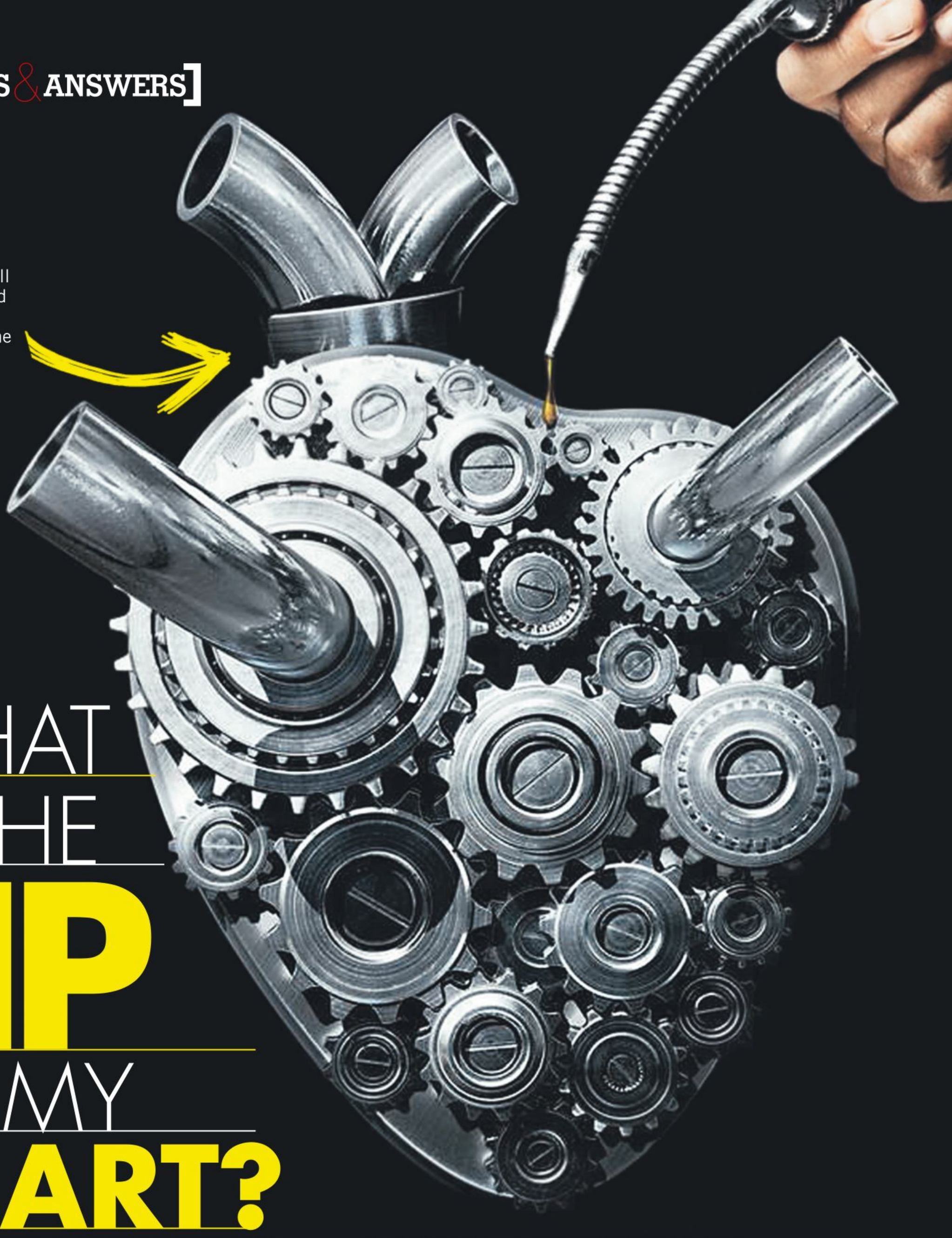
[QUESTIONS & ANSWERS]

A diesel engine will run for only around 5,000 hours. The human heart on the other hand beats for an average of 657,000 hours.



WHAT IS THE HP OF MY HEART?

The human heart is often referred to as the 'engine of life'. But how does this motor measure up to real engines, the like of which you'd find in a typical sports car? The heart's resting capacity is the equivalent of a 580 horsepower engine – at least that's what physicists have calculated to be the basic energy gain of the blood while pumping. The fist-sized heart of a human pumps around 70 times per minute, with each 'pump' delivering around 80 millilitres of blood through the arteries. That's about 8,000 litres per day – in energy saving mode. In its highest gear, the heart can send up to 1,200 litres of blood through the body every hour. Over the course of an 80-year lifetime, it will beat three billion times – that's three times as much as other mammals. By the time you die, your heart will have pumped more than 200 million litres of fuel through your body.

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10 OF THE MOST EXPENSIVE MATERIALS

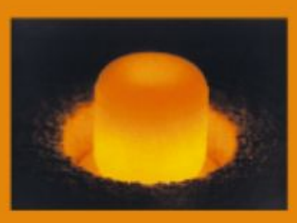
1 Californium 252: £19 million/g
The isotope is used to measure moisture during crude oil drilling.

2 Painite: £210,000/g
This extremely rare mineral is mostly used as a stone in jewellery or as a collectible.

3 Diamond: £45,000/g
The hardest natural material in the world is primarily prized for its use in jewellery.

4 Tritium: £21,000/g
A cheaper, gaseous tritium variant is used in self-illuminating emergency exit signs.

5 Taaffeite: £14,000/g
Discovered by chance in 1945, this is among the rarest gemstones in the world.



6 Plutonium: £2,800/g
A fissile material produced from the uranium fuel elements in nuclear power plants.

7 LSD: £1,500/g
In crystal form, the hallucinogen can fetch £2,600 per gram.

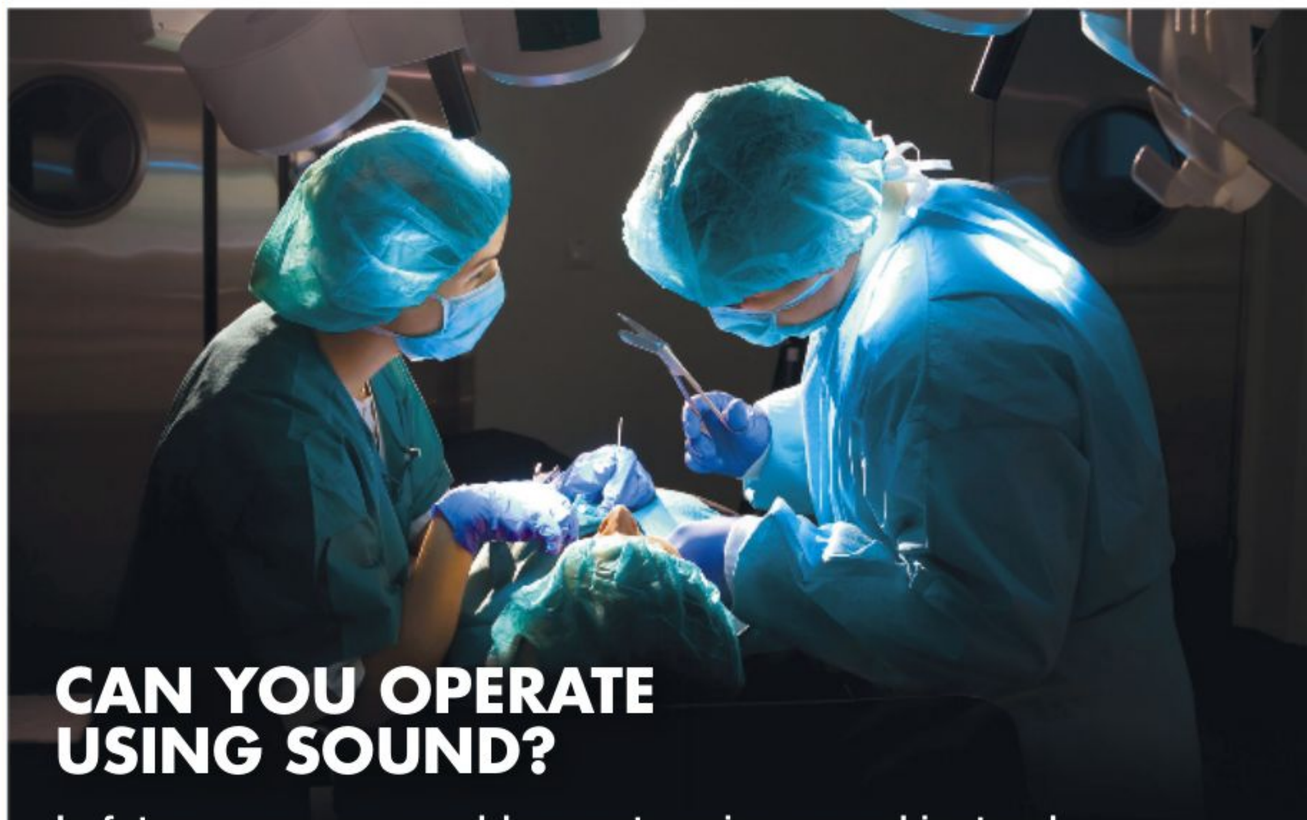
8 Cocaine: £300/g
Even before it reaches the dealer on the street, cocaine is rarely more than 25% pure.

9 Methamphetamine: £80/g
Pure crystal meth is considered the most destructive drug in the world.

10 Heroin: £75/g
For heroin in its purest form, junkies must cough up around £75 per gram.

Which year was the **longest in history?**

A year consists of 365 days. But that was not always the case. In fact, one year in history lasted 445 days. This exceptional year was due to a comprehensive calendar reform by Julius Caesar in the year 46BC. Prior to this, chaos had reigned because the Roman calendar system always lagged behind the astronomical solar year. In 46BC Caesar wanted the following year to end punctually with the winter solstice – so they waited until this occurred, adding an extra three months.



CAN YOU OPERATE USING SOUND?

In future surgeons could operate using sound instead of scalpels. Scientists have succeeded in converting pulsed laser light into high-amplitude sound waves. When focused on a target area, the concentrated energy is able to control tiny objects in the air or cut through human tissue – like an invisible pair of surgical forceps or a scalpel. This could revolutionise non-invasive surgery and allow previously unreachable areas of the human body to be operated on with outstanding precision.

PHOTOS: DDP; Corbis (2); Getty Images; Alamy; Shutterstock; Bauer Stock (5); iStock; PR (4)

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MINERAL CATAPULT

These orange smudges are dust, whirling into the atmosphere from the Earth's surface. This picture illustrates how the majority of dust comes from the deserts. Rich in nutrients, it crosses the Atlantic and brings fertilisers to the South American rainforest.

AIR POLLUTER

This harmless looking green haze actually highlights one of the biggest ongoing environmental disasters. It's the smoke from forest fires lit to clear wooded areas in Malaysia and Indonesia.

PLANET

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HOW MUCH DUST IS FLYING AROUND THE EARTH?

● This NASA simulation makes an invisible universe visible. Every year five billion tons of dust from the Earth's surface are flung into the atmosphere. These natural and manmade aerosols circle the globe in ten days. The moving particles are composed from dust (orange), salt particles from the oceans (blue), smoke (green) and gases and sulphates (white). The wind carries them at a height of 4,000-6,000 metres from Asia to Europe and from Africa to South America. The dust is thickest above the major cities of Europe, North America and China.

CLIMATE CONTROL

The white haze seen here primarily consists of tiny particles from industrial emissions that form during the burning of fossil fuels. Parts of it are sulphates emitted by algae when ocean temperatures rise and the water becomes too warm. The sulphates also generate clouds.

No filter is 100% effective against it and nothing can stop it in its tracks: every year dust kills millions of people while simultaneously giving life to an entire continent. *Wonderpedia* opens up the mysterious universe of microparticles...

DUST

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TSUNAMI OF DUST

● It takes just three minutes for everything to go dark in the American city of Phoenix. The gigantic sandstorm – a haboob – forms a wall of sand and dust that can weigh up to 100 million tons and instantly disables mobile phone and electricity networks. For the next few hours the streets of Phoenix are empty. Most haboobs occur during Arizona's summer months, when the air is forced down and pushed forward by the front of a thunderstorm cell, dragging the dust and sand with it. While the sand rises to a height of about 20 metres, dust particles can climb to 3,000 metres and travel for thousands of miles before being dumped down again.

The study conducted by public health administrator Dr John Howard takes over 5,000 days. Sixty thousand volunteers take part – many without realising it. But all of them have been infected for more than 14 years. Infected with an everyday substance that kills millions of people every year: dust. Never before have experts been able to gather such wide-reaching evidence about the effect of microparticles on the human body. The name of the project? The World Trade Center Health Control Program. The start date: 11th September 2001.

HOW DANGEROUS IS THE 'WORLD TRADE CENTER COUGH'?

Tens of thousands of police officers, firefighters and construction workers were affected. They all inhaled the dust of the destroyed Twin Towers, and in the

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process breathed in a toxic brew made from ten million tons of pulverised building material (steel wool, lead, glass fibres and asbestos) as well as 90,000 litres of jet fuel.

In the days following the attack billions of dust particles invaded deep into the lung tissue of the 9/11 responders and local workers – leaving behind a trail of devastation. Those affected complained of headaches, breathing difficulties, asthma and digestive tract diseases. Just two years after the terror attack more than 2,000 firefighters had been declared unfit for work. By 2011, according to Howard's long-term observations, 18,000 people were suffering from the effects of the 9/11 dust tsunami. The most prevalent ailment which affects thousands today is known as the 'World Trade Center Cough'. As well as a chronic cough, symptoms include long-term sinus inflammation, difficulty breathing and heartburn. Other responders suffered from pulmonary fibrosis following the clean-up work after 9/11. "As a result you lose the ability to

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THE CLOUD-MAKER

● Without dust this cloud cover over the city of Chicago wouldn't exist. Moisture attaches to the tiny particles, facilitating the formation of water droplets and ice crystals. Dust becomes a particularly good rainmaker when it accelerates the development of ice crystals in the cold upper layers of cloud. These ice crystals grow quickly and induce further precipitation when they fall through the clouds – the rain or snowfall gathers strength and becomes heavier. Amazingly, the weather in the US is impacted by Asian dust. Researchers have now shown that weather fronts in America have their roots in Asia, where they form two weeks before hitting the States.

exchange carbon dioxide with oxygen," says Howard, who coordinated the response to the health effects of 9/11. "The lungs develop internal scarring, meaning the alveoli must work harder. This makes breathing laboured." Some of those affected were treated using cortisol-containing drugs and oxygen inhalers; the most serious cases underwent, or are awaiting, a lung transplant. Without this, they'll die. But fine dust don't just attack the body after major catastrophes. Across the world, these microparticles kill people every day.

HOW MUCH DUST CAN THE LUNGS WITHSTAND?

Shortly before Christmas 2015, Beijing declared a 'red alert', denoting the highest level of smog. To stem the pollution, factories were shut down, traffic stopped and residents were ordered to stay at home. In China smog kills an astonishing 4,000 people every day – almost 1.5 million per year. But this isn't just China's problem: each year 9,500 Londoners die as a result of particulate dust inhalation, and across the UK air

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pollution is linked to 30,000 deaths annually. “Air samples can contain over 10,000 compounds and science can currently only identify a few,” says radiation expert Wolfgang Kreyling. If the particles measure less than 10 micrometres, they cannot be filtered out by the mucous membranes of the nose and throat. This fine dust burrows into the lungs and blood vessels, smuggling toxic substances into the body. Asthma occurs when these particles inflame the airways and block the supply of oxygen to the lungs.

Even on Barbados, hundreds of miles from any other land mass, the number of asthma cases as a result of dust inhalation have skyrocketed. Today 17 times more residents suffer from respiratory conditions than did in the 1970s. The reason behind this can’t be found on the Caribbean island itself, but 5,000 miles away in Africa. There, deforestation, increased water usage and intensive agriculture mean the ground is extremely barren. Global wind currents are carrying more and more dust to Barbados. The amount of

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HOW MUCH HUMAN IS FOUND IN DUST?

● It doesn't matter whether it's mountains, trees or humans – at some point everything turns to dust. Accordingly, dust is composed of minerals, fungi, spores, pollen and dead skin cells among other things. House dust consists of up to 80% bodily waste, like skin flakes. In coastal areas, dust is primarily made up of salt crystals, while in the country, you'll find plant spores in large quantities. What effect dust particles have on the environment and on humans depends on their size.

THE BIGGEST DUST CATAPULTS

Wind currents dissolve the tiniest particles from the desert soil and carry them around the world at an altitude of 5,000 metres. After the Sahara in Africa, the deserts of Asia and Australia are the world's foremost dust slingshots. Only some of the sand falls to the ground during a sandstorm; the remainder moves with global wind systems from the Sahara to Europe in the spring and over the Atlantic in summer.

desert dust that arrives there today is five times higher than in the 1970s. And the particles exert their power in several places…

IS DUST CHANGING THE SEA?

"We suspect that dust from North Africa is responsible for the deaths of coral reefs in the Caribbean," writes US geologist Gene Shinn. His team have been observing the effects of dust on the oceans for years. The particles hinder the energy production of corals. "They reflect the sunlight and light up the clouds," says Dr Paul Halloran, a geography professor at the University of Exeter. As a result less light can reach the sea surface which means the corals have less fuel for their energy production through photosynthesis.

Unfortunately dust is far more than just a harmful substance – because the world is also dependent on it. While coral reefs are threatened by dust, other ecosystems need it to survive. Take the rainforests of South America, for example. They need Saharan dust

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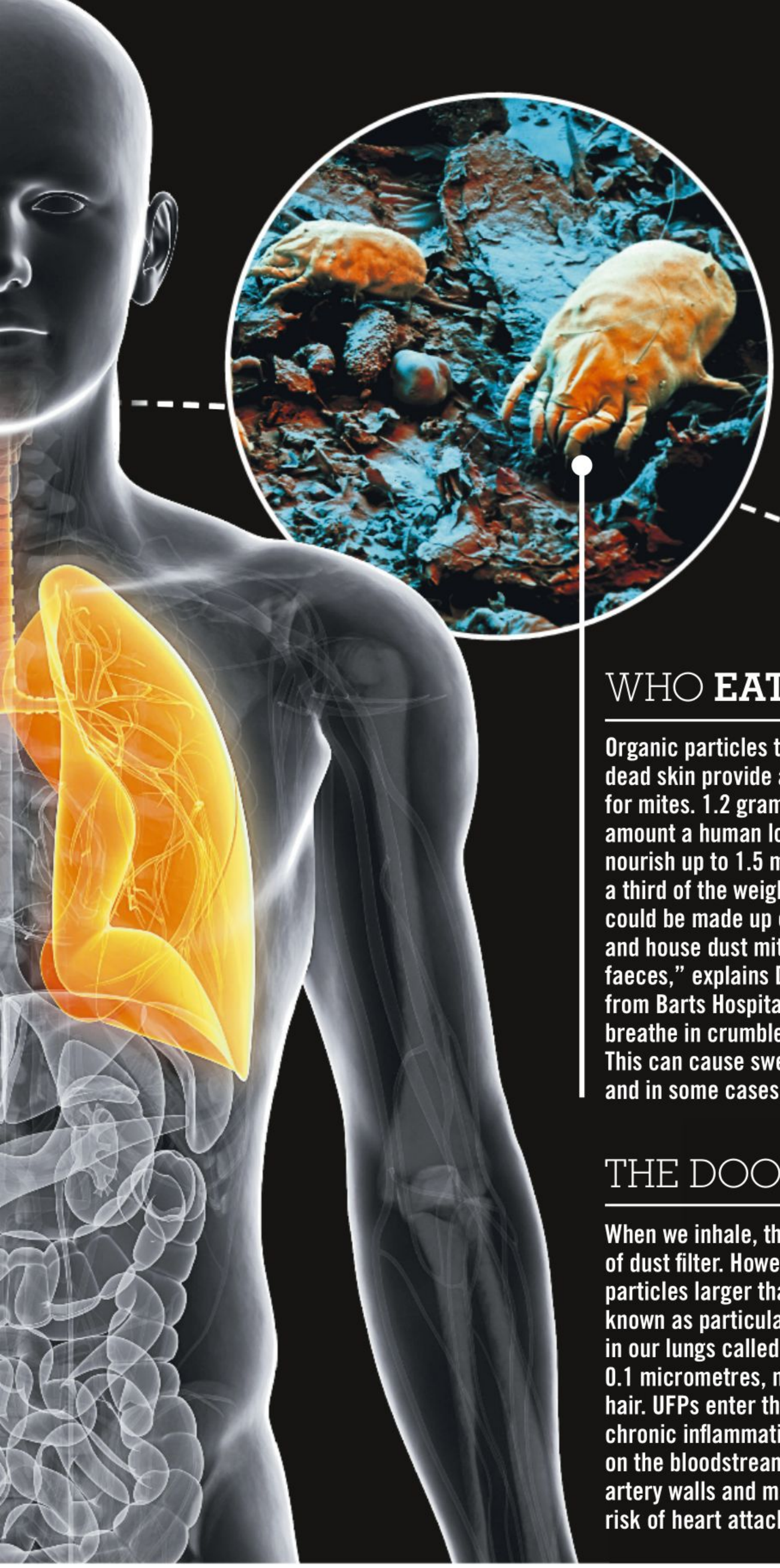
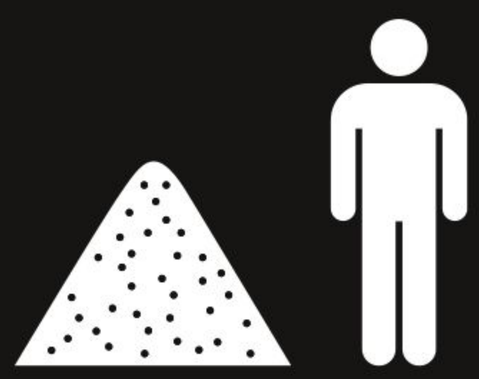


THE HUMAN **DUST MACHINE**



26 KG

is the amount of skin particles a human will lose in their lifetime, on average. Dead skin cells make up a large part of the dust in a home.

GERM BOMB: **DUST**

Desert dust that is carried around the globe by the wind also contains bacteria, pollen (above, pink) and fungi. One gram of desert dust contains up to 10,000 potential disease-causing organisms.

WHO **EATS DUST?**

Organic particles that humans lose as dead skin provide an ideal food source for mites. 1.2 grams of skin, the amount a human loses a day, can nourish up to 1.5 million mites. “Up to a third of the weight of your pillow could be made up of bugs, dead skin and house dust mites and their faeces,” explains Dr Arthur Tucker from Barts Hospital. Humans then breathe in crumbled mite faeces again. This can cause swelling of the airways and in some cases can lead to asthma.

THE DOOR TO **THE BLOODSTREAM**

When we inhale, the mucous membranes in our respiratory system function as a kind of dust filter. However, these membranes are only effective against coarser dust particles larger than 10 micrometres (0.01 millimetres). Dust smaller than this is known as particulate matter; it’s so tiny it can even penetrate the minuscule sacs in our lungs called alveoli. Ultrafine particles (UFPs) are even smaller still at just 0.1 micrometres, making them 1,000 times smaller than the diameter of a human hair. UFPs enter the blood directly and increase the risk of circulatory disorders and chronic inflammation, which can lead to cancer. The precise effects of the particles on the bloodstream is still unclear. US researchers suspect that they harden the artery walls and make blood vessels calcify more quickly. This in turn raises the risk of heart attacks, stroke and other circulatory diseases.

because tropical soil lacks nutrients. It’s estimated that 27.7 million tons of Saharan dust settles in the Amazon every year, and minerals contained in this shower, carried by the wind, act as fertiliser for the soil.

Even the weather would be drastically altered without dust. The billions of particles act as ice nuclei for tiny water droplets to attach to and the droplets grow when the particles collide. In this way water vapour falls as raindrops and ice crystals. US researchers from the Scripps Institute of Oceanography have discovered that, without these particles, clouds would only be able to form the conditions necessary for snow at temperatures of minus 38 degrees Celsius and below. So in effect, every raindrop is enabled by the speck of dust held within it. These dust particles form part of a micro-universe that, to this day, we understand only a fraction of. It’s one in which the tiniest particle can be both the saviour of the rainforests – and the number one enemy of the human body.

PHOTOS: NASA; Flickr; Jim Richardson/WWF; SPL/Agentur Focus (2); Getty Images; BSIP; Manfred Kage Mikrofotografie

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[SMARTER IN 60 SECONDS]

4 FASCINATING QUESTIONS ABOUT DUST

Where is the biggest vacuum cleaner in the world?

The Dutch city of Rotterdam holds this distinction. Its 'Smog Free Tower', a dust-fighting giant measuring seven metres by three-and-a-half metres, could lead to clean air around the world. The technology behind it? A ventilator sucks in dirty air like a giant vacuum cleaner. Ion technology then filters it, before returning bubbles of smog-free air through the tower's vents. The result: 30,000 cubic metres of smog-free air per hour, despite using less energy than it takes to boil a kettle. In future, the tower could be deployed in polluted megacities like Mumbai and Beijing.

What does **house dust** know about crime?

Criminologists can analyse house dust to find out who was at the scene of the crime. Every day we shed skin particles and, as a result, tiny amounts of DNA. US researchers succeeded in identifying the human DNA of different people in dust samples. Further research could streamline criminal analysis to the extent that individual gene profiles could be created from dust.

Can you **buy fresh air?**

What do you do if the air in your city is just too smoggy for you to breathe easily? That's right, you order fresh Canadian air by the can! The products made by the firm Vitality Air have become instant bestsellers in China, where the first shipment of 500 bottles sold out in just four days. Chinese customers had a choice between 'pure oxygen' and 'fresh air' drawn from Canada's Banff National Park. The equivalent of £20 bought shoppers 7.7 litres of fresh air, enough for 150 inhalations.

How much **stardust is in your body?**

Without cosmic dust particles there would be no living organisms, no oceans, no mountains, no Earth and – obviously – no humans. But why? Around 4.5 billion years ago stardust released during a gigantic explosion gradually accumulated into a mass that got bigger and bigger – our Earth. Contained in the dust particles were all of the chemical elements that would become the building blocks of life. From these rivers, deserts, plants and animals developed. That means that us humans are, in the broadest sense, built entirely from stardust.

PHOTOS: NASA; Shutterstock; SPL/Agentur Focus; PR

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SPOTTER
$13,000 buys a firearm that allows a beginner to outshoot a professional sniper. The lion's share of this outlay goes on the tracking optic, which calculates the variables that affect trajectory. These include windspeed, temperature and the weight of the projectile.

CRACK SHOT
Eight times better than an elite marksman: a decent sniper releases shots within 10cm of a designated target from a distance of 900 metres. This gun only fires when the current margin of error is less than 1.3cm.

HOW DO YOU

Brandon has never held a gun in his hands, let alone a sniper rifle. Yet here he is, kneeling on the ground, the stock of a 1.16-metre-long TrackingPoint 750 308H pressed into his shoulder. After a short introduction, the rookie takes aim and three muffled shots echo around the rifle range. Incredibly, all three hit the bull's eye. Even more incredibly, it's not just 20 metres that separates Brandon and the £2 coin-sized target, but a cool 700 metres – seven times the length of a football field. It's rare for even the army's best crack shots to shoot from that distance. Is Brandon a natural? Not in the slightest. In truth, he only selected the target – the rifle aimed itself. The shooter is merely the owner of an unbelievably precise technology – one that makes missing a thing of the past…

"The rifle uses the same advanced technology as modern fighter jets."

John Lupher, co-founder of TrackingPoint

CAN ANYONE BECOME A PROFESSIONAL SNIPER?

"The rifle uses the same advanced technology as modern fighter jets,"

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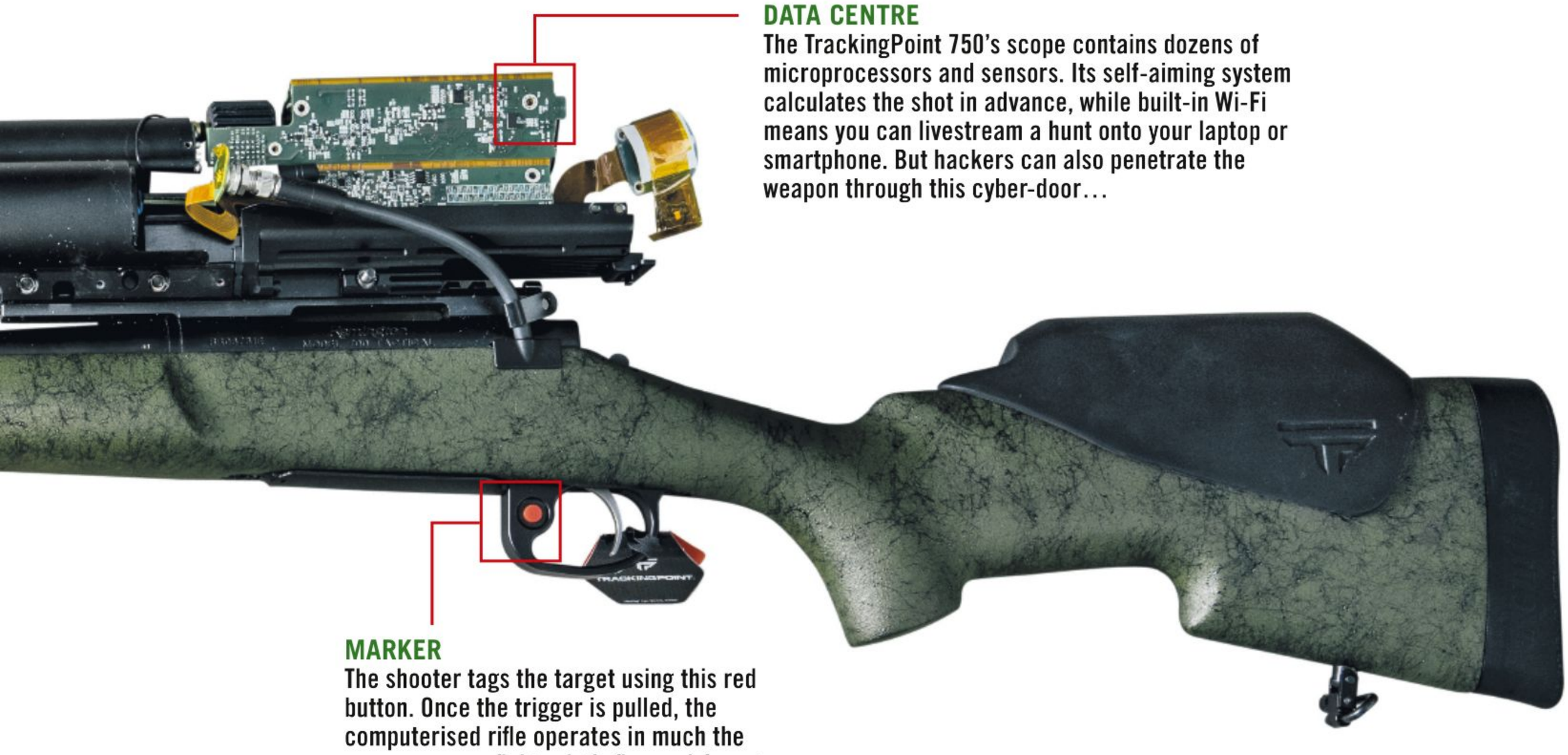

DATA CENTRE
The TrackingPoint 750's scope contains dozens of microprocessors and sensors. Its self-aiming system calculates the shot in advance, while built-in Wi-Fi means you can livestream a hunt onto your laptop or smartphone. But hackers can also penetrate the weapon through this cyber-door…

MARKER
The shooter tags the target using this red button. Once the trigger is pulled, the computerised rifle operates in much the same way as a fighter jet's fire-and-forget system: it chooses the exact moment to release the round, waiting until the barrel is perfectly aligned to hit the target.

Experts are getting increasingly concerned about intelligent weapons. Some 'smart guns' can connect to the internet, aim using algorithms and hit the target 100% of the time – as long as no one hacks into them, that is…

HACK A WEAPON?

explains John Lupher, co-founder of TrackingPoint, the rifle's manufacturer. "That means anyone who picks one up can shoot better than an expert marksman." But how does it actually work?

Instead of using a conventional telescopic sight, a laser rangefinder shows the field of view and is used by the shooter to identify the target that he or she wants to hit. Using a red button next to the trigger, the shooter 'tags' the target. Then, after the trigger is pulled, the computerised rifle itself chooses the exact moment to fire: the shooter can relax, stretch, even pose for a photo, safe in the knowledge that the rifle will take care of everything – even when faced with a moving target…

In principle, the computer does the same thing as the sniper's brain – only faster and more accurately: TrackingPoint's software calculates the influence of temperature and wind speed on the projectile's trajectory. It 'knows' the exact force of the propellant charge when the 11.4g bullet leaves the muzzle at more than three times the speed of sound. It calculates to the millimetre where the $13,000 weapon must point to land a direct hit. Even nervous and uncertain marksmen will let off perfect rounds – the fire control system won't let poor aim, jerk or jitter affect the shot.

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Given that the shooter is in charge of the weapon, it might seem like he has full control over the shot and therefore has at least some level of proficiency. In reality, though, his job is extremely simple: by holding the rifle in roughly the right direction he can outshoot a professional sniper with years of training under his belt…

Bystanders can follow this process in real time because the weapon is online – it can livestream everything to a smartphone or iPad. And it's this that offers a backdoor for hackers: the gun's network has a default password that allows anyone within Wi-Fi range to connect to it. Hackers can treat the gun as a server and manipulate its functions. "We can change the gun's targeting variables or render its rangefinder inoperable," explains IT security expert Runa Sandvik. "The shooter wouldn't initially notice the malfunction because everything would look perfectly normal on the screen." Together with her husband Michael Auger, Sandvik has managed to reprogram the TP 750 308H multiple times.

"We can change the gun so that it can no longer fire and more besides. The shooter wouldn't notice the malfunction to begin with because everything would look perfectly normal on the screen."

Runa Sandvik, IT security expert

GUN HACKERS
Runa Sandvik (left) and her husband Michael Auger managed to hack into the electronics of the rifle.

HOW INTELLIGENT CAN A WEAPON BE?

So far it hasn't been possible to fire the rifle remotely, but in certain situations the consequences of a 'hostile takeover' of the weapon could still be dramatic: in the worst case, a hacker could force a police sniper to miss while trying to shoot a hostage-taking criminal – and hit the hostage instead. Or a hacker could simply lock the rifle's controls, rendering it useless. This risk is far from being merely theoretical: in 2014, it was revealed that the US Army would never use a TrackingPoint rifle in a hostage rescue mission – because a sniper usually has only one chance in such extreme situations.

More widely, the hacking of a relatively expensive and rare rifle is just the tip of an iceberg: experts foresee further problems with some of the more high-tech weaponry that is completely revolutionising the industry, including so-called smart guns. These are 'intelligent' firearms that recognise who is pulling the trigger – meaning, in theory, that only the registered owner will be able to fire them. The background: in the USA, the largest private arms market in the world, there are over 300 million firearms in circulation, one for every citizen in the country – including babies and the elderly. On average, 90 people are shot dead in the US

TARGET MARKER
The shooter selects the target himself, but the rifle chooses when to release the perfect shot.

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every day – in many cases, parents are killed by a child mistaking their gun for a toy. Or there are young people like Adam Lanza who, in 2012, took three of his mother's firearms and carried out a mass shooting at Sandy Hook Elementary School. Even policemen can fall victim to their own service weapon if a criminal manages to wrestle it off them. It's estimated that 20,000 lives a year could be saved if weapons were intelligent and could only be fired by their owner. But how does the technology work – and how secure is it?

WHAT DOES A GUN HAVE IN COMMON WITH AN IPHONE?

Smart guns such as Armatix's iP1 contain a computer that links up with a transmitter worn on the owner's wrist. The gun can remain active as long as there is a connection – without this the trigger mechanism is blocked and the gun becomes just a lump of metal, useful only for throwing at someone. Some models also feature a fingerprint scanner similar to those used to unlock an iPhone. Others identify their rightful owner by his or her handgrip. But the system isn't perfect yet: "In an emergency, when the life of a police officer depends on their weapon, there can be no uncertainty. If you had dirt on your hands and tried to use the fingerprint scanner, the pistol wouldn't fire," says Wolfgang Dicke, former national director of the German Police Union. This fear of the technology failing is widespread – as is the legitimate fear of electronic intruders…

DOES A GUN NEED ANTIVIRUS SOFTWARE?

"Are you afraid that someone could hack your credit card information?" asks Mark Keefe of the National Rifle Association, a US organisation that lobbies on behalf of gun owners. "Well, what if a criminal, hacker or even the government could turn your gun on and off?" Several years ago the state of New Jersey passed a law that required retailers to sell smart guns – and *only* smart guns – three years after they reached the market. But no one seriously doubts that it's only a matter of time before hackers can access even the most advanced smart gun systems. In the case of the TrackingPoint 750 308H, it only took weeks. "In hacking there's an established race between attackers and defenders," explains security expert Dan Kaminsky. "Today, attackers have many opportunities and defenders have very few. At the moment, nobody knows how to make a computer really secure."

That smart guns like the Armatix iP1 haven't yet been hacked is probably down to there being so few around: at the moment, they're hard to buy and therefore scarce. That will change when viruses become as common in firearms as they are on computers…

"In an emergency, when the life of a police officer depends on their gun, there can be no uncertainty. The shot has to definitely count."

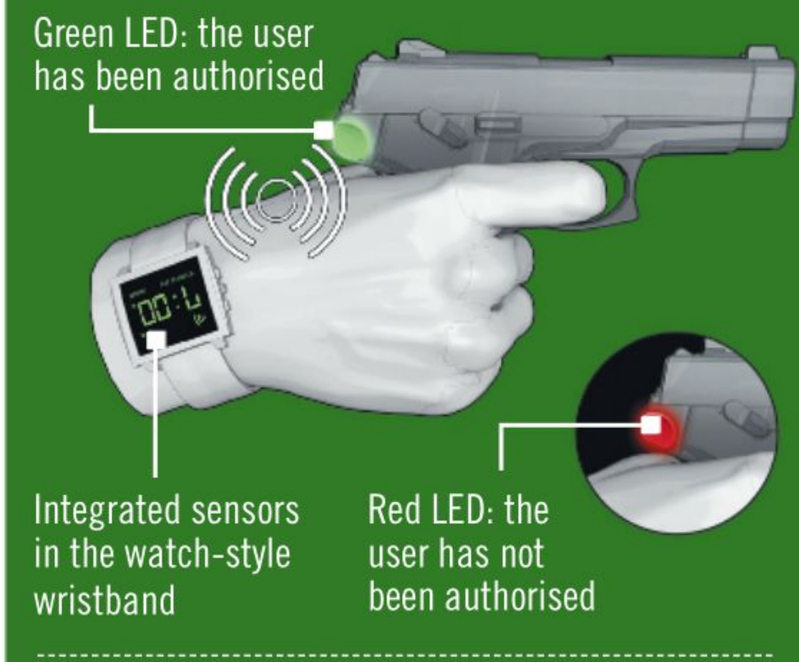
Wolfgang Dicke, former national director of the German Police Union

PHOTOS: Greg Kahn. ILLUSTRATION: B. Ramis de Ayreflor/wdw-Grafik

HOW DO WEAPONS BECOME INTELLIGENT?

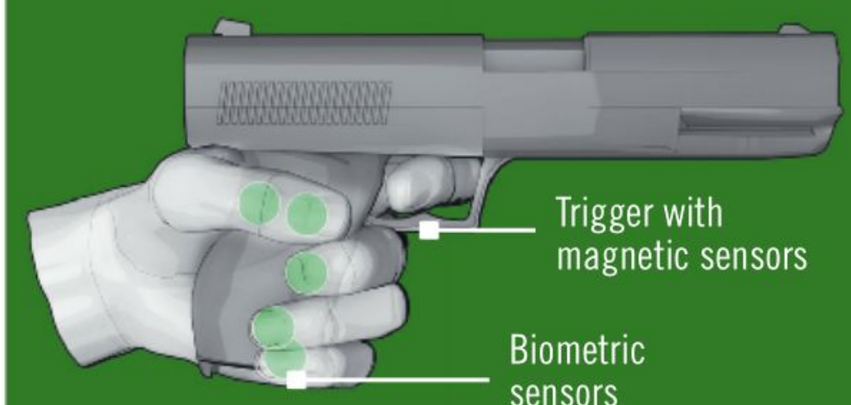
To avoid accidents and thefts, only the owner can fire the weapon. But how does a handgun know who's pulling the trigger? Three systems are currently on offer

1. RADIO: The gun can only fire within range of a transmitter, which the owner must wear on their wrist. A green light indicates when it's ready to fire.



2. SCAN: The pistol reads the fingerprints of potential shooters and only lets its registered owner fire. This system is similar to the fingerprint scanners in modern smartphones.

3. GRIP: The weapon 'recognises' its owner's grip – the size of their hand, the amount of pressure exerted and so on. For this to work, the owner has to grasp the pistol in different ways when registering it.



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CAN MY BRAIN TAKE ME HOSTAGE?

ANXIETY
BURNOUT
PARANOIA

How your own thoughts can hold you hostage - and how to free yourself again...

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"CERTAIN **IMPULSES** TAKE OUR **THOUGHTS** HOSTAGE"

he task is deceptively simple: the test subjects are left alone with their thoughts in a waiting room for 15 minutes. Smartphones are banned and there are no distractions – the only object in the room is a Taser-style stun gun. All of the participants are healthy and have shown they have control of their own actions. But what study leader Timothy Wilson observed rendered even the most experienced US psychologists speechless. After a few minutes, the subjects began to give themselves electric shocks in an effort to stem the boredom. Despite the pain, many did not appear deterred and continued to shock themselves. One man even pressed the button over and over again, subjecting his body to 190 jolts in 15 minutes. That's when Wilson realised just how easy it is for our senses to be taken hostage by one of our closest allies: the brain…

Believe something similar could never happen to you? That you always have control of your thoughts? And that you're the master of your own will? In reality, all of these assumptions are illusions. Psychologists and neurologists have now proven that parts of our brain take our thoughts and desires hostage every day – using very different weapons, motives and claims to control our behaviour. This situation usually occurs when there is an imbalance in our brains. For example, if the senses are deprived of stimuli, as in the waiting room experiment, a part of the brain will artificially create one – even an electric shock, if need be. But why does the brain do something that isn't good for it?

"Modern life is a welter of assorted desires marked by frequent conflict and resistance, the latter with uneven success," explains psychology professor Wilhelm Hofmann from the University of Cologne. This tug of war between impulse and resistance is visible in our everyday desires. "The younger areas of the brain that evolved later pursue different interests to the more established regions," Hoffman continues. "The younger part allows us to make future plans and uses willpower to make sure the plans come about. The older parts generate impulses and deal with the here and now. They are important because they ensure that we eat, sleep and have sex. The brain rewards these behaviours with a sense of well-being."

But there's a catch: in order to achieve a quick reward, the impulses sometimes take reason hostage. "Chocolate instantly tastes good, but the process of losing weight takes time. You don't see the benefits immediately," says Hoffman. The mind isn't turned off for this to happen – instead the reward system secretly sneaks into our thoughts and kidnaps them. The result? We think more and more about just how good it would feel to eat the chocolate. It's only when we carry out this desire that the ransom put >

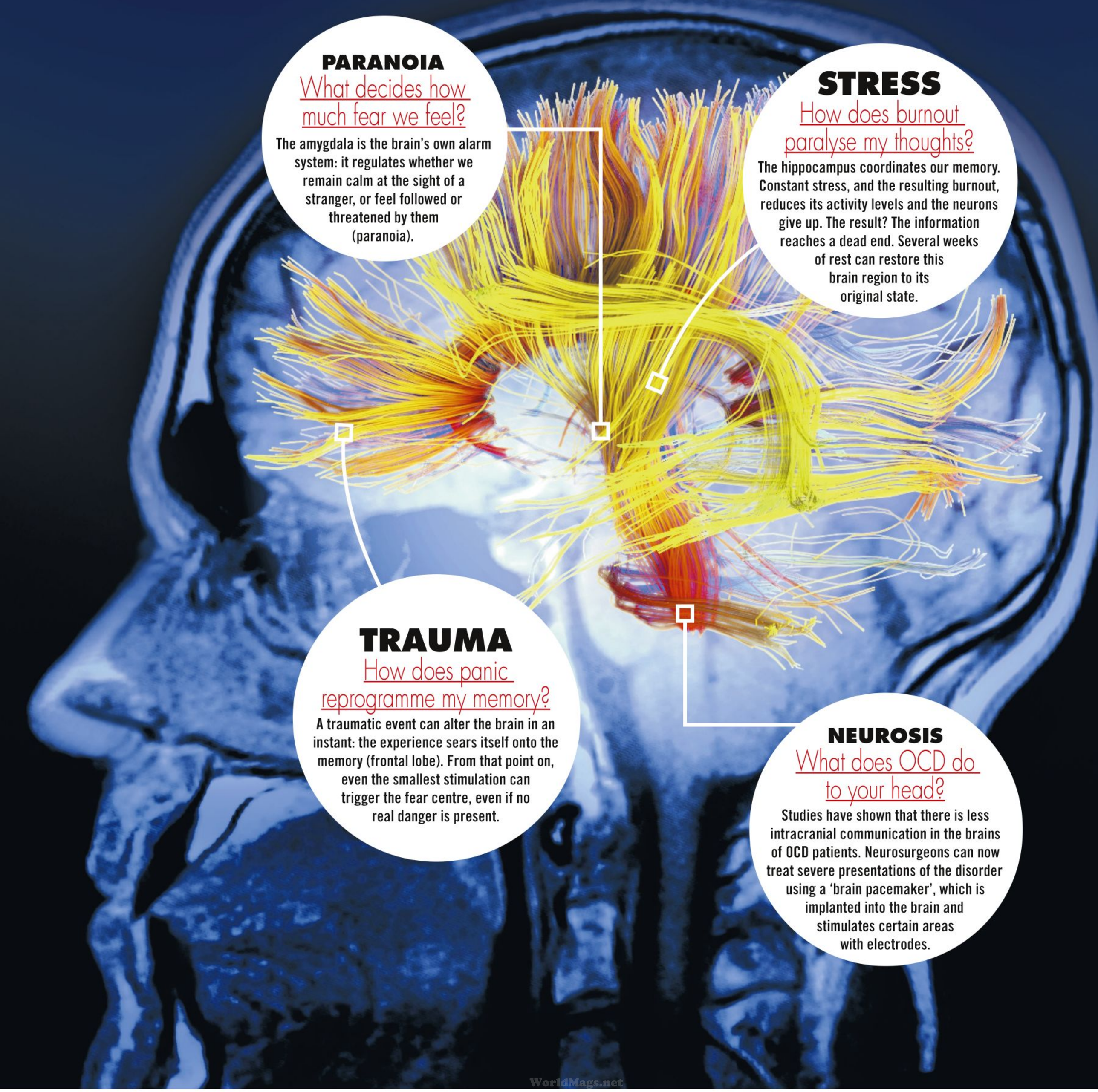
Psychologist

WILHELM HOFMANN from the University of Cologne

Wilhelm Hofmann studies the psychological processes that determine our thoughts, feelings and behaviour – things we do not consciously control. Among other things, he asks: how do we come to concrete decisions? When and why do people act impulsively or more thoughtfully in certain areas of life – such as when they're eating, drinking or experiencing anger?

WHERE DO THE **4 KIDNAPPERS OF MY THOUGHTS** RESIDE?

The human brain is home to 100 billion nerve cells. Working in unison they are able to perform up to ten trillion operations per second. That's provided they are not taken hostage! The four hostage-takers below do not attack the neurons themselves, instead they block some of the brain's two million miles of neural pathways that connect the neurons. This means important impulses are lost or misdirected.



PARANOIA

What decides how much fear we feel?

The amygdala is the brain's own alarm system: it regulates whether we remain calm at the sight of a stranger, or feel followed or threatened by them (paranoia).

STRESS

How does burnout paralyse my thoughts?

The hippocampus coordinates our memory. Constant stress, and the resulting burnout, reduces its activity levels and the neurons give up. The result? The information reaches a dead end. Several weeks of rest can restore this brain region to its original state.

TRAUMA

How does panic reprogramme my memory?

A traumatic event can alter the brain in an instant: the experience sears itself onto the memory (frontal lobe). From that point on, even the smallest stimulation can trigger the fear centre, even if no real danger is present.

NEUROSIS

What does OCD do to your head?

Studies have shown that there is less intracranial communication in the brains of OCD patients. Neurosurgeons can now treat severe presentations of the disorder using a 'brain pacemaker', which is implanted into the brain and stimulates certain areas with electrodes.

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"OUR **CONSCIOUSNESS** DOES NOT HAVE ACCESS TO ALL OF **OUR THOUGHTS"**

TIMOTHY WILSON

Psychologist

TIMOTHY WILSON

from the University of Virginia

Professor Wilson researches the influence of the unconscious mind on human decisions and behaviour. The psychologist is convinced that the subconscious regions of the brain are involved in everything that we do. Wilson believes the unconscious to be the universal system of the psyche given its ability to make decisions completely automatically.

up by the brain is met and our thoughts can roam free again.

A similar process is experienced in relation to feelings of guilt. In that instance, however, it isn't the reward system being captured, but the prefrontal cortex – the area of the brain responsible for the formation of moral values. If someone has a guilty conscience, their neural activity increases in this region – until they admit their guilt or it is discovered. Neurologists have discovered in various studies that the bigger the lie and the longer you carry it around with you, the greater the strain on the brain. "Lying is cognitive hard work," explains psychologist Renate Volbert from Berlin's Charité hospital. "The neural stress caused by lying is so severe that there's hardly any space for other thoughts to exist." The consequence is that our nerve centres try to release us from captivity. A war breaks out – between our willpower, which wants to keep the secret, and our unconscious brain, which wants to restore the neural order. The latter usually emerges victorious and betrays us. But not all of the hostages emerge unharmed: particularly long-lasting conflicts in the brain may lead to psychological, and even physical, harm. This means there is a fine line – from a neural perspective – between craving a chocolate bar and a cocaine addiction; between a guilty conscience and paranoia; between wanting to have everything in order and obsessive neuroses; between a negative memory and a huge trauma; between stress and burnout.

But what really happens inside our heads in these kinds of exceptional situations? Why do certain areas of the brain wage war against us? And how can these brain 'kidnappings' be prevented? Helped by leading scientists and psychologists, *Wonderpedia* examines the brain's greatest enemies.

Hostage-taker

BURNOUT

WHAT HAPPENS IF **MY BODY** WORKS FOR TOO LONG?

The warm jet of water from the shower massages Moritz Erhardt's tense back. The 21-year-old exhales and closes his eyes – for the first time in 72 hours. Keen to impress his boss, the finance intern at Bank of America Merrill Lynch has just worked for 72 hours straight, stopping only to take a taxi home for a quick shower. But this moment of relaxation in the shower comes too late. What Moritz doesn't know: his brain has been affected by the exhaustion of long hours – with fatal consequences. The next day, Moritz's lifeless body is found on his bathroom floor. The coroner's finding: Moritz did not suffer an overdose of drugs or alcohol. Instead, he suffered a devastating epileptic seizure, which may have been caused by stress. Coroner Mary Hassell said: "One of the triggers for epilepsy is exhaustion and it may be that because Moritz had been working so hard, his fatigue was a trigger for the seizure that killed him."

In fact, the World Health Organisation (WHO) has declared stress to be one of the 21st century's biggest threats to health. In the UK alone, one in five people suffer from extreme stress. However, it's only in exceptional circumstances that acute symptoms such as Moritz's emerge. The process is usually stealthier. The result? Burnout. But how exactly does stress damage and transform the body over time?

Whether it's deadlines at work, family arguments, sitting in a traffic jam every day while commuting or too little sleep – the world is full of negative stressors. They affect your hormones and levels of cortisol. If stress is a rare occurrence in your life, then the risk to your health is low. But in cases of prolonged and chronic stress, your health can be permanently damaged. A recent study by scientists in New York, for example, found that even mild levels of stress can impair a person's ability to keep their emotions in check. For people genetically predisposed to certain diseases, like cancer or diabetes, chronic stress can hasten their onset by weakening the body's immune system. And the immediate effects of stress are equally unpleasant: we feel tired, burnt-out and unmotivated.

Burnout isn't the only consequence of being held captive by stress: acute stress causes inflammation, leading to ulcers and increased risk of heart disease and cancers. But how can you recognise when stress is taking over your system? How can you prevent this hostage situation?

THE SEVEN SIGNS OF BURNOUT

1. *ZERO TOLERANCE*
You quickly lose patience: the queue at the till or on-hold music makes you angry.

2. *YOU CAN'T SAY NO*
Your own needs are put on the back burner and you often work overtime.

3. *YOU'RE ALWAYS AVAILABLE*
Studies have shown that people who spend more than an hour per day talking on their mobile phone increase their risk of burnout by 70%.

4. *A MOUNTAIN OF PAPERWORK*
The assignments grow, the phone rings constantly, your desk is overflowing – the burnout threshold has been reached.

5. *YOU'RE A CYNIC*
If you make scathing remarks or scornful jokes about those around you, you're trying to relieve pressure on yourself.

6. *YOU CANCEL APPOINTMENTS*
You often cancel or move arrangements.

7. *NOISE SENSITIVITY*
You notice barely audible sounds around you. Even the sound of a ticking clock makes you nervous or irritated.

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Hostage-taker

TRAUMA

CAN MY **MEMORIES** TORTURE ME TO DEATH?

The explosion roars into the open as if from nowhere. Elite solider Scott Ostrom is thrown from his off-road vehicle. When he opens his eyes, the bloody arm of his driver is stretching towards him. Ostrom wants to help – but he can't move. His brain holds him prisoner. Like a vice it paralyses his arms and legs. Although he is looking straight at his colleague, Ostrom can do nothing to help – he is reduced to a helpless puppet. His comrade dies in front of his very eyes…

Nearly ten years have passed since that explosion in Iraq. But the memories continue to haunt Ostrom – they've held him hostage ever since the incident. Medically speaking, he suffers from post-traumatic stress disorder (PTSD). Today, certain noises cause the former soldier to break into a panic or fits of rage. His life is dominated by nightmares, flashbacks and anxiety. The traumatic experience has strongly shaken his psyche. And not only that: "Brain imaging studies of PTSD have identified a few key brain regions whose function appears to be altered in PTSD, most notably the amygdala, the prefrontal cortex and the hippocampus," explains Dr Philip Newton from Swansea University Medical School.

However, it's not just soldiers who can become hostages of their own memories, so can victims of bullying or sexual abuse. A trauma is, in principle, caused by an overdose of panic. If you're scared of dying, large amounts of cortisol and adrenaline are released in order to stimulate the flight or fight reflex. This flood of hormones alters the way memories are stored. The result: the brain burns the experiences into memory, sometimes making them permanently present. Many sufferers commit suicide as a result of this constant mental torture. The death of one solider has the potential to lead to many more deaths by suicide.

But how can you stop this torture? "There shouldn't be any professional intervention in the acute phase, the first 48 hours after the trauma," explains psychologist Willi Butollo from MIT's traumatherapy unit. The memories are too raw, the risk of retraumatisation too high. After that, it's possible for the inner hostage to escape – in some cases without help. The main escape route: live through the hell of the traumatic thoughts. Because the key to coping with trauma is to deal with the memories in the head. But how?

FOUR STRATEGIES TO FIGHT TRAUMA

1. *KEEP A DIARY*

Write down all thoughts and feelings about the traumatic experience. Doing this will help manage fears.

2. *PRACTISE EMDR*

'Eye Movement Desensitisation and Reprocessing' involves the victim moving their eyes 20-40 times to the left and right while recalling the trauma. This should be repeated this until the intensity of the memories is weakened.

3. *BUILD ON FAMILIAR, POSITIVE EXPERIENCES*

Read a favourite book; go for a walk to the local park or take up a sport you have enjoyed in the past again.

4. *CONSULT A PSYCHOTHERAPIST*

Professional help should be sought if the trauma triggers symptoms such as panic attacks, and these don't disappear after a period of four weeks.

Hostage-taker

PARANOIA

HOW DO I PREVENT MY **NERVES FROM DRIVING ME MAD?**

It took precisely seven years for Victor Kristensen, a young Dane from the country's second biggest city Aarhus, to be transformed from model student to determined ISIS jihadist. But his conviction is just a façade, as one propaganda video shows: in it, the 21-year-old looks uncertain and confused. His brain appears to have been reprogrammed and his thoughts are remote-controlled. He murmurs prayers while he talks.

A group of forensic psychologists evaluated the video and found: Kristensen was ill, suffering from paranoia and felt persecuted. His thoughts drove him to madness. Shortly after the propaganda video ended, Kristensen got rid of the kidnapper of his thoughts – in a bloody way. He chose the last resort to rid himself of his supposed persecutors: under the nom de guerre Fatih al-Denmarki, he blew himself up in a suicide attack on an Iraqi Army post – and killed 50 people in the process…

But how did a 'normal' boy become a mass murderer? "Salafists are generally a perfect example of a group of people with a paranoia disorder," explains French psychologist Asma Guenifi. "They feel persecuted and believe that they and their community are in danger and must be defended. They project their violence outwardly." But not everyone who suffers from delusions is an assassin. An estimated 0.5 to 2.5% of the population show symptoms of paranoid personality disorder. They

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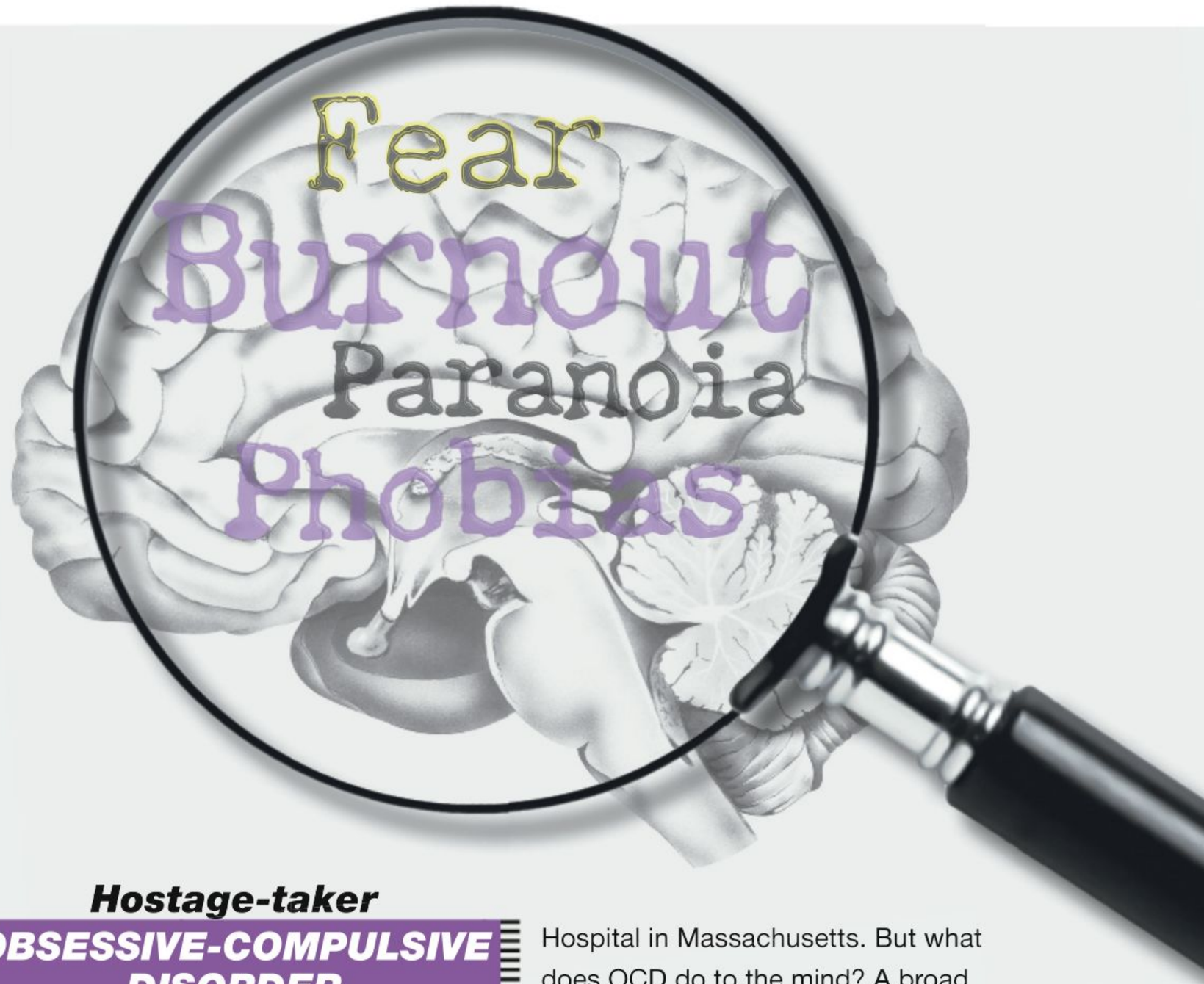

sneakily become the absolute rulers of the mind.

But how do these imaginings come about? A film running in the head invents adversaries and, after a certain amount of time, we become isolated – the brain then more or less talks to itself: for example, it perceives certain people as enemies, no matter how they behave. In an experiment at King's College London, most people experienced a harmless virtual train ride, but paranoiacs saw themselves as being surrounded by enemies. In contrast, too much information can amplify the paranoia: "Too much TV or excessive playing of computer games can upset the brain," said psychologist Elmar Basse.

But how do you distinguish between commonplace fears and a paranoid hostage-taker in your head? Behavioural scientist and former FBI agent Joe Navarro has created this paranoia checklist…

THE SIX SIGNS OF PARANOIA

1. Is unduly suspicious of others.
2. Is highly moralistic and judgmental.
3. A guarded and secretive personality.
4. An excessive fear of unlikely things.
5. Holds grudges for a long time.
6. Shifts blame on others.

If you meet more than two criteria, fight the paranoia using the following strategies: 1) Question supposed facts: are other explanations possible? 2) Try to recognise triggers: are there places or people which trigger especially strong fears? 3) Avoid drugs and alcohol: chemical substances often trigger paranoia. 4) Distract yourself: even a phone call to someone you trust can help break down fears. 5) Seek professional help.

Hostage-taker

OBSESSIVE-COMPULSIVE DISORDER

CAN I **FORCE MY MIND** TO ACT **AGAINST MY WILL?**

Alex was 11 when he first flicked the computer screen with his finger. It was a kind of 'good luck flick' for an email he had just sent to a girl. And lo and behold, she answered him. Today, Alex is 21 – and his mind has been taken hostage by OCD. The flick dominates his life: "Whenever I enter a room, I have to flick the bottom-left corner of every rectangular object," he says. Alex's bizarre ritual of flicking all the windows, artwork and picture frames in his house means he has to get up at five o'clock every morning. But how can his thoughts be hijacked like this?

The hostage-taking often begins with a seemingly innocuous quirk – and ends in years of tyranny. "I'm afraid that something bad will happen if I don't do it," explains Alex. "These diffuse fears are so strong that people will do literally anything to escape them," says Jeff Szymanski from the Obsessive Compulsive Disorder Unit at McLean Hospital in Massachusetts. But what does OCD do to the mind? A broad network of neurons in the brain is responsible for thoughts and feelings. This ensures that negative thoughts quickly evaporate under normal circumstances. But this process is massively disrupted in OCD sufferers – the 'switch' that prevents processed thoughts from resurfacing only works in them intermittently. The result: thoughts that would normally have been discarded are transmitted over and over again. At the same time, this chaos unbalances an important chemical messenger so that the absorption of the 'happiness' hormone serotonin decreases. The person develops OCD. How can you get rid of this kidnapper?

HOW CAN YOU FIGHT OCD?

Cognitive behavioural therapy and a course of antidepressants can help keep OCD at bay in 50% of cases. Recently, a Paris team discovered that deep-brain stimulation can limit the effects of OCD in 70% of cases: an electrode is implanted in the brain and an impulse generator worn on the body suppresses urges by passing currents to the implant. The impulse generator acts as a kind of remote control when symptoms occur.

PHOTOS: Getty Images; Fotolia (2); Corbis; Truthful Brain; PR (2)
ILLUSTRATION: Getty Images

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THE SEARCH FOR FLIGHT MH370

THE MYSTERY OF THE 7th ARC

The Seventh Arc is one of the most dangerous and most under-researched regions on the planet. It's here, in the middle of the southern Indian Ocean, that experts suspect that the missing Boeing of flight MH370 crashed. *Wonderpedia* investigates the most expensive and wide-reaching search operation in history...

It's the middle of the night when the MV Fugro Equator's highly sensitive ground sonar sounds the alarm. Some 1,600 miles off Australia's west coast, in the endless grey of the southern Indian Ocean, the ship's crew crowd round the monitor. The screen shows a large cluster of anomalies on the seafloor. "There's something in the water," shouts Captain Chris Morris over the radio. "We have contact!" Back at HQ, Peter Foley listens intently. Foley's the man in charge of the most exhaustive search mission in history – the hunt for MH370.

Hurriedly, the engineers release Echo Surveyor VII, an autonomous underwater robot equipped with a high-definition camera, into the ocean. Their hopes rise – have they finally found the wreckage of flight MH370? But as the first live pictures of the seabed appear on the ship's monitors, the initial euphoria quickly turns to disappointed silence. It's an anchor. The Equator's sonar has discovered a shipwreck. Yet Foley still marks the day with a red cross on his calendar: "It's a fascinating find, but it's not what we're looking for," he says. "But this event has demonstrated that the systems, people and the equipment involved in the search are working well. It's shown that if there's a debris field in the search area, we'll find it."

But how could a Boeing 777 just disappear into thin air? What makes the search for MH370 so dangerous? And how much time do the experts on the Equator have to solve one of the most mysterious cases in aviation history?

>

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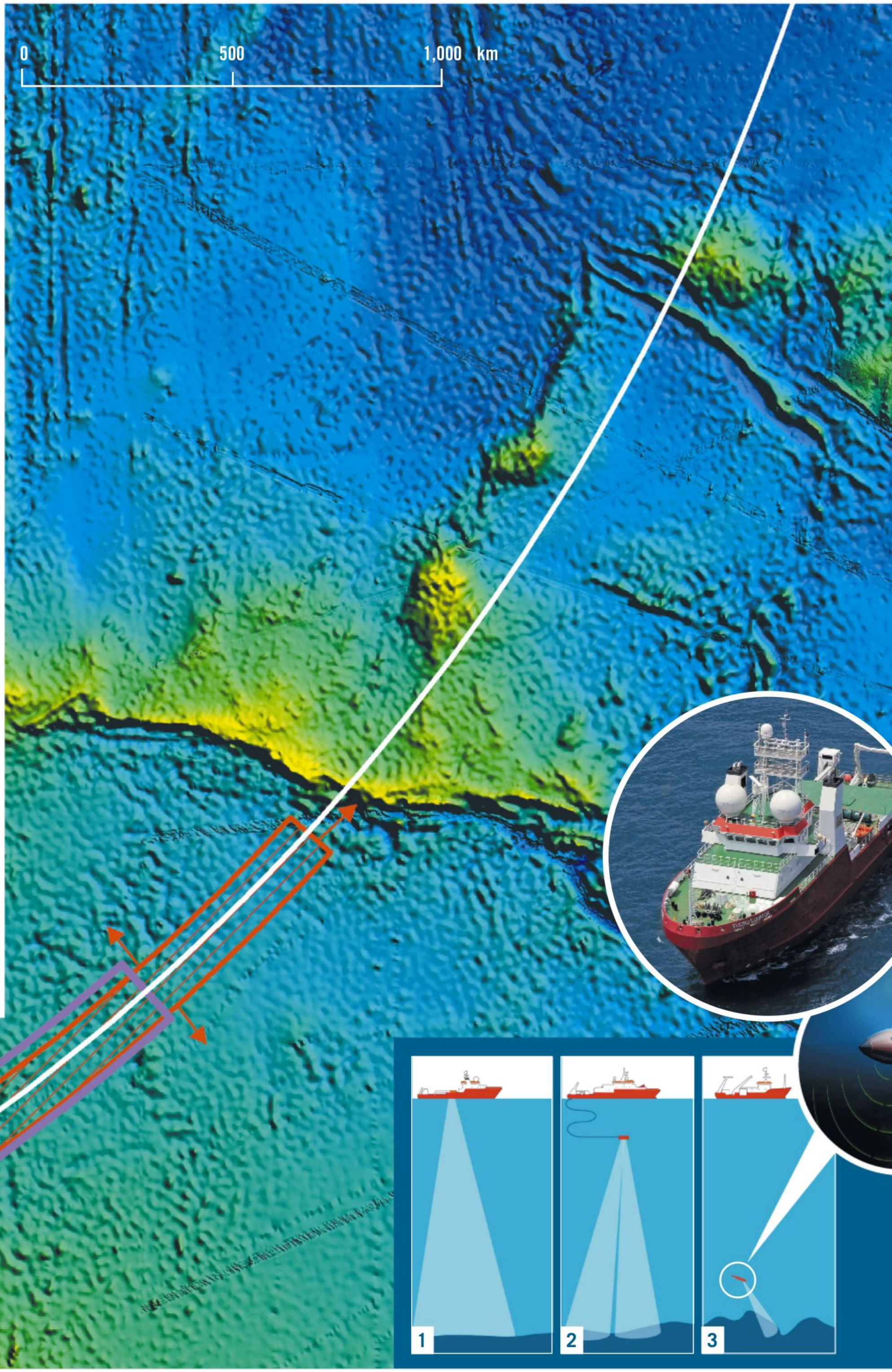
THE ANATOMY OF THE 7TH ARC

Using the flight data available from MH370 as well as thorough analysis of satellite data and flight simulations, the Seventh Arc has been determined as the most likely crash zone (see map). The region in the southern Indian Ocean is roughly the same size as England and is up to 5,000 metres deep in places. A 46,000-square-mile area of seabed is to be mapped as part of the operational search. 60% has been mapped and scanned so far.



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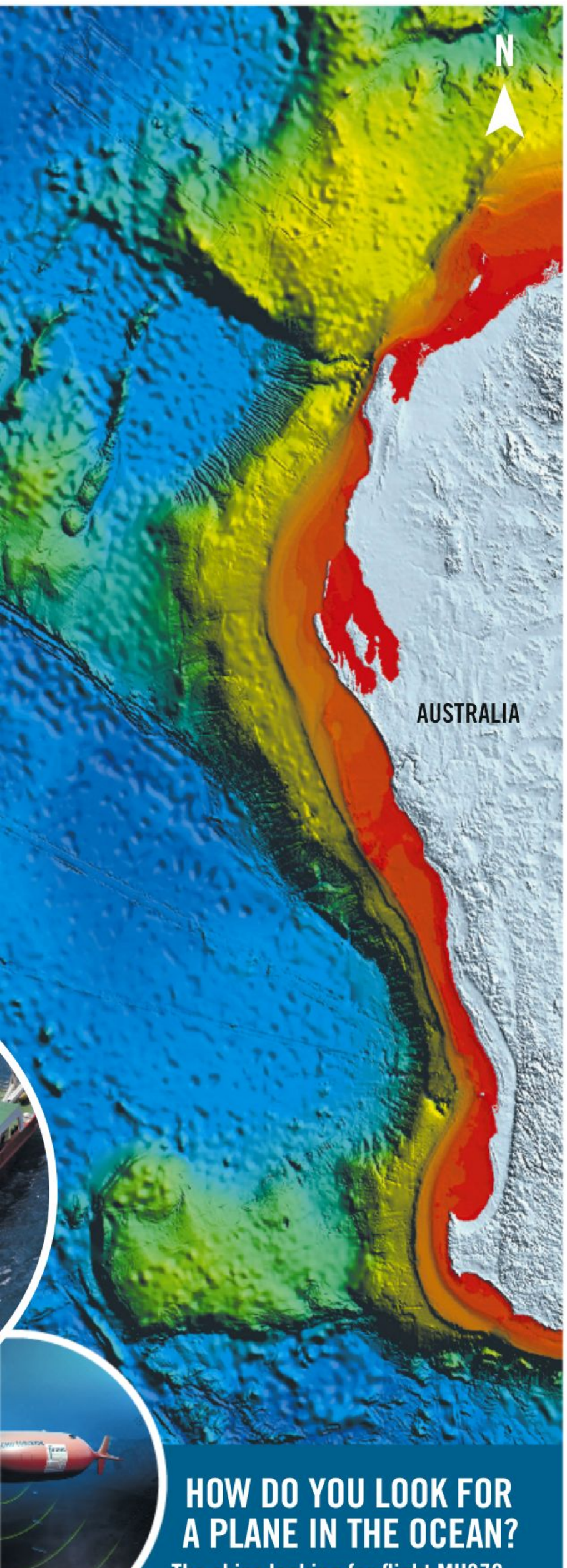

HOW DO YOU LOOK FOR A PLANE IN THE OCEAN?

The ships looking for flight MH370 use three methods in their search: with the ship's own echolocation tools, experts build a rough map of the ocean floor (1). A towfish attached to a mile-long cable maps the seabed in precise detail, aided by sonar instruments (2). If anomalies are observed on these scans, an autonomous underwater vehicle (AUV) equipped with a camera is sent into the depths to investigate further (3).

"GOOD NIGHT, MALAYSIAN THREE SEVEN ZERO."

Last words from the cockpit of Flight MH370 from Kuala Lumpur to Beijing

To understand the background to the search for MH370, we need to rewind two years. At 12.14am on 8th March 2014 a Boeing 777 takes off from the Malaysian capital Kuala Lumpur. It's due to fly northeast towards Beijing. At the controls is Zaharie Ahmad Shah, an experienced flight captain with more than 18,000 flying hours under his belt. The skies are clear.

Like every plane flying this route, MH370 also passes through a continuous communication network; every aeroplane checks in with airspace control as soon as it flies into a particular region – and does so again when it leaves. At 1.19am the pilot signs off from Kuala Lumpur's air traffic control tower with the words, "Good night, Malaysian 370." It is the last sign of life from the 239 people on board. Seconds later the plane diverts from its planned flight path, turning back towards Malaysia and disappearing from the radar at 1.22am. Sixty-eight minutes after take-off, the Boeing 777 has seemingly vanished into thin air.

Never before has such a scenario occurred with a plane of this size – and certainly not in one of the world's busiest flight corridors.

Yet even after the disappearance of MH370 there are still 'signs of life' emanating from the plane. For the next seven hours the plane's on-board computer broadcasts an hourly 'ping', also known as a handshake, to a satellite operated by British firm Inmarsat positioned 11 miles above the Indian Ocean. Admittedly, it's a rudimentary signal: all the ping from the on-board computer is really confirming is "I'm still here." It doesn't reveal the plane's exact location. But then this signal stops.

An international search operation follows: 42 ships and 39 planes from 12 countries scan the ocean surface for wreckage for weeks on end, initially in the South China Sea and then in the vast stretch of Indian Ocean between Malaysia and Australia. A more in-depth analysis of the satellite data reveals that the lost Boeing must have crashed somewhere in the southern Indian Ocean. Using the calculated fuel usage of the plane, weather data from the night of 9th March 2014, and analysis of the prevailing currents in the days after the crash, an area termed the 'Seventh Arc' is recognised by specialists in the months after the disappearance. This is a corridor measuring 46,000 square miles along which flight MH370 is believed to have crashed.

But if you think that narrowing down the search to this defined area has made the task any easier, then think again. Remember, the searchers are not looking for a 60-metre-long steel tube (it's highly likely that the plane broke up into thousands of piece when it crashed) – instead their focus is a shoebox-sized black box that holds MH370's flight data and the secrets to its disappearance… >

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> “Imagine towing a trailer five miles behind your car. **In the dark. On mountain roads.**”
>
> *Survey leader Scott Miller on the search for the plane in the Indian Ocean*

Search director Paul Kennedy is finding it difficult to keep his footing on the command bridge of the rocking Equator. Waves the height of houses crash against the ship’s steel walls; groaning, the 2,000-ton colossus battles through the wild waters of the southern Indian Ocean. Visibility is less than 50 metres, sometimes as little as five metres when surf shoots up onto the bow. “The southern Indian Ocean is a dreadful place,” says Kennedy. Indeed, the defined search area is one of the most remote and dangerous regions in the world. The nearest mainland is a week away by boat. Cyclones can build mountains of water up to five storeys high and the Roaring Forties, the belt of westerly winds between 40 and 50 degrees latitude in the southern hemisphere, often give rise to storms that are some of the most feared in seafaring.

Dutch search and recovery team Fugro provides all three ships that are still engaged in the search for MH370. As well as the Equator, sister ships Discovery and Supporter are scanning the ocean floor. The ships’ state-of-the-art equipment includes several diving robots called AUVs (autonomous underwater vehicles), as well as ‘towfish’ (sonar devices that can be tugged behind the ships). The ships’ surveillance rooms, lined with dozens of monitors, look like central command centres of government intelligence agencies. The crew works non-stop in 12-hour shifts, even though sleeping during the breaks is rendered practically impossible by the waves. Each bed is kitted out with a safety belt, though even these are sometimes no use.

Every few months the ships return to port in Perth, Australia, to replace the exhausted crew. Perth is where the command centre of the operational search for MH370 is based. To date the international search has cost more than £80 million, but giving up has never been an option for the Fugro team. While money is an issue, the biggest challenge they face lies not on land, but at sea. Under the ocean’s surface…

In the corridor of the Seventh Arc, the seabed can be up to 5,000 metres deep. Mountains the size of the Alps rise up from the seafloor. Gigantic crevices, some double the size of the Grand Canyon, run like scars through the mountainous formations. The region’s valleys are also some of the most scantly researched on Earth. Many of the crevices on the seabed are geological hotspots. Underwater volcanoes known as black smokers emit clouds of particle-laden fluid from the Earth’s crust at temperatures of 400 degrees Celsius: a dangerous cocktail that is distributed throughout the eternal darkness of the deep sea. Given the conditions, Kennedy is not surprised that a 60-metre

VALLEYS OF DARKNESS
“The sea floor is made up of mountains and valleys. It’s difficult to see anything,” explains Rob Luijnenburg, director of the Dutch Fugro fleet that’s scanning the southern Indian Ocean for flight MH370.

HIGH-TECH SONAR
The Equator is equipped with what's known as a towfish: a million-dollar, unmanned underwater vehicle that scans the seabed using sonar. It's attached to a cable almost a mile long.

object could vanish in this dark, rugged underworld: "But in this case we're talking about a plane that had 239 people on board. So we can't just accept that fact."

And that's the very reason why, despite the canyons and cliffs, the Equator is pulling a towfish behind it at a depth of several thousand metres. The two-metre ground sonar scans every millimetre of the seabed on a three-kilometre strip. All of the data is sent back to the ship via a cable, where it is collected and evaluated with the help of a satellite link to the control centre in Perth. In split seconds a live image of the seabed's topography is created – including possible anomalies that stand out, like the shipwreck discovered by Captain Morris and his crew.

Each towfish scans 100 square kilometres of the sea floor per day. The box is also equipped with an anti-collision sensor as well as a hydrocarbon 'sniffer' to help it avoid possible collisions with rocks. But there's still a certain residual risk of losing the cable attached to the sonar device. "Imagine towing a trailer five miles behind your car. In the dark. On mountain roads," says survey leader Scott Miller, about the challenge of a towfish deployment in this region.

During the analysis of debris on the seabed the search team specialists split items into three categories: **1.** Not of interest. **2.** Interesting but unlikely to be MH370. **3.** It's the plane, call HQ! Whenever an anomaly in the second category is found, the five-metre-long robot is released into the depths. Using its high-definition camera it delivers live images back to the search team. The crew of the *Equator* are, of course, still waiting for a category 3 discovery, even though Paul Kennedy and his team have already mapped 60% of the area. They hope to scan the remaining region by June, at which point they will have to end the search. No country is prepared to pay for the search to be extended, as it would mean widening the search area by thousands of kilometres in all directions. It's an impossible task, even for the experienced and highly-specialised crew in charge of the Fugro fleet.

As it stands, the search is costing thousands of pounds every day. It's something the engineers and technicians on board the Equator are acutely aware of – so much so, in fact, that they have volunteered to work without a break until June. They will scan the Seventh Arc 24 hours a day, seven days a week. "I'm determined to find it. I'm not leaving this job until I've done what I came out to do," says Scott Miller, observing from the bridge as the Echo Surveyor VII is released into the churning sea. Somewhere in these forbidding waters, a small black box is hiding. A box that holds all the answers to the unsolved mystery of MH370…

PHOTOS: Australian Government (2); FUGRO (2); DPA; ABIS; PR

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ARTIFICIAL OILFIELD
This access shaft to the Jurong Rock Caverns in Singapore is over 20 metres wide. The rock gets tougher the deeper it gets – at a depth of 100 metres it's strong enough to house a huge storage hangar, which will hold up to 1.5 million cubic metres of oil. In total, five miles of tunnels have been built underground.

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SINGAPORE IS GROWING INTO THE EARTH

HOW DEEP CAN YOU BUILD A CITY?

The Burj Khalifa, Shanghai Tower, One World Trade Center – more and more skyscrapers are breaking height records around the world. But one city is heading in the opposite direction: Singapore is the first to develop below the ground – and to create a second city in the deep...

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Singapore is a world power in miniature. Spread over 62 islands and situated at the southernmost tip of the Asian mainland, it's both a city and a state. Despite being just half the size of London, the island city-state has an economy 420 times larger than Finland's. And even if plans to reclaim 40 square miles of seabed by 2030 go ahead, the city would still have a chronic problem – lack of space…

HOW DO YOU BUILD A CITY BENEATH A CITY?

In Singapore it is now almost impossible for a person to be buried after they die. The last major cemetery, Bukit Brown, was cut in half to make way for an eight-lane highway in 2015 because, in the eyes of the city's governors, it was wasted space – a commodity that is, without doubt, the city's most precious resource.

"We inherited the island without its hinterland, a heart without a body," Lee Kuan Yew, Singapore's first Prime Minister, famously said. Today two airports and six military air bases are squeezed into the city, while three times as many containers pass through Singapore than at Europe's biggest port, Rotterdam. The city-state is one of the most important commercial and financial centres in the world, and it's also the third largest location for processing oil. One of its plants produces more than the largest refinery in Saudi Arabia. The 5.5 million-strong metropolis also has a well-equipped army, which, together with its reservists, is four times the size of the British Army.

But how do you squeeze all that onto a patch of land that's already overloaded with high-rise apartment complexes and skyscrapers? The solution lies underground: "When land prices are very high and there's not a lot of room to grow, that's when you see cities developing subways or basements," says

"The lack of land is forcing Singapore to think in a three-dimensional way: land may be scarce – but space isn't."

Joshua Comaroff, Lekker Architects in Singapore

5.5 SECOND FALL
The access shafts for storing oil plunge 150 metres into the ground – deeper than the London Eye is high. It takes a stone close to six seconds to reach the bottom.

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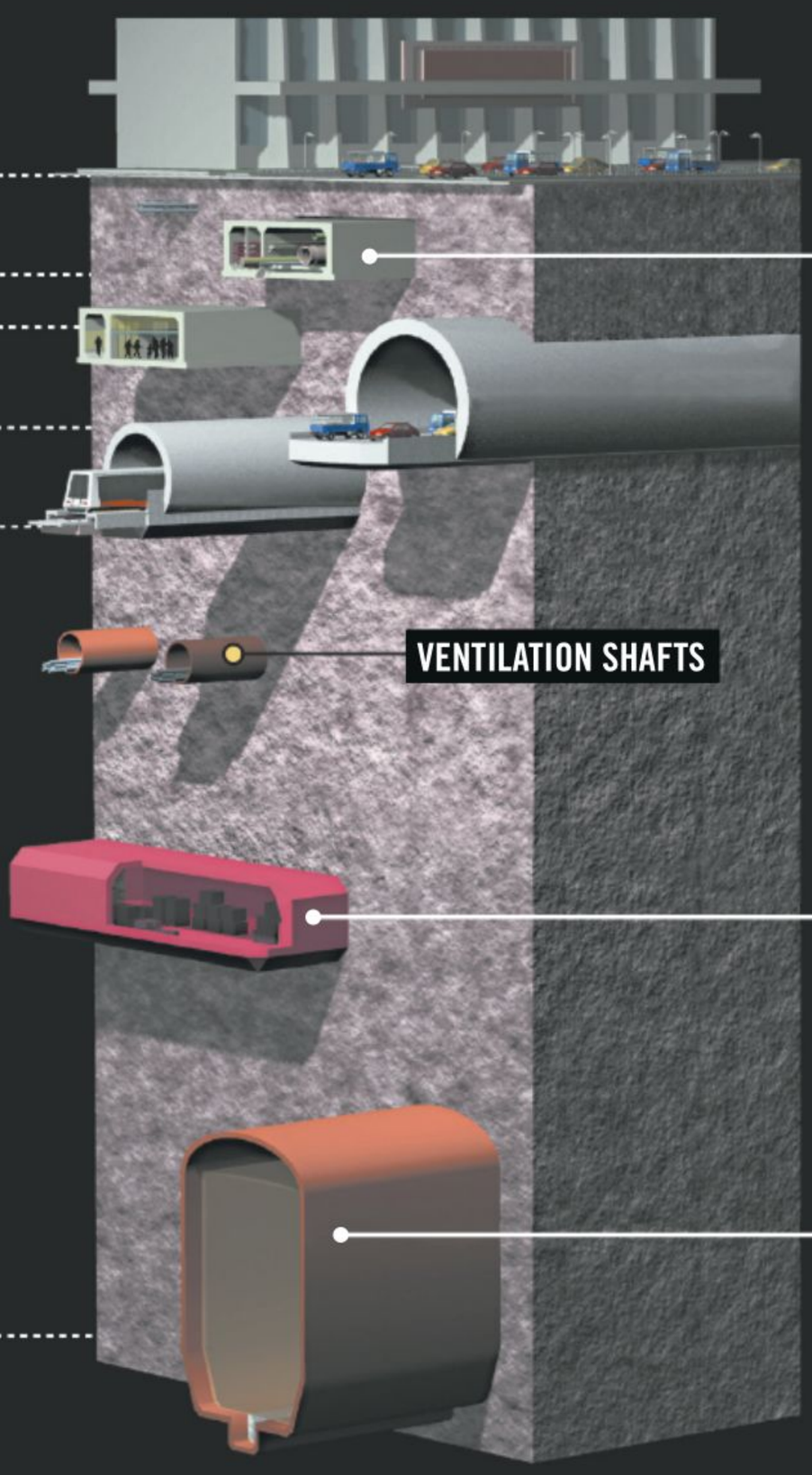
A CITY BENEATH THE CITY

It's ten times more expensive to build below ground than it is above. But with undeveloped open space scarce in the mini-state and one square metre of land now costing the same as in New York, there's no other obvious solution for Singapore. The underground city will be layered: the top will be reserved for essential services and facilities such as public transport and shopping centres. Further down will be oil reserves and ammunition depots.

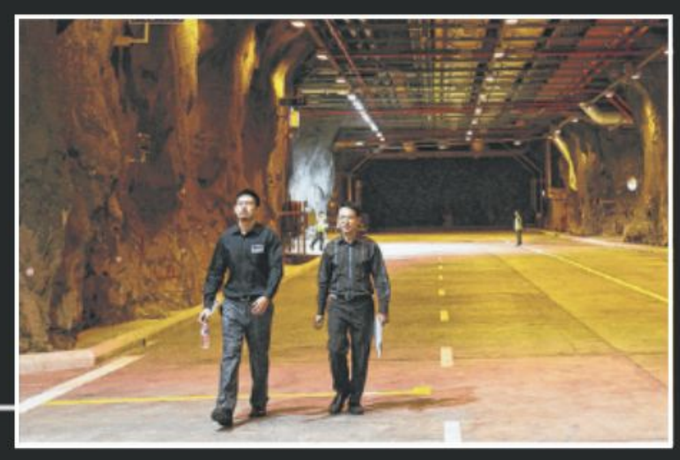
0 TO 20 METRES
Water and gas pipes and supply tunnels.

15 TO 40 METRES
Offices, shopping centres, car parks and research laboratories.



30 TO 150 METRES
Things like cables, oil pipes and ammunition depots are buried deep underground. Though expensive to build, they require little human intervention to run.

SERVICE TUNNEL This passageway provides access to Singapore's oil and gas network, among other things.



AMMUNITIONS DEPOT Empty at the moment, this hall is one of two ammunition stores for the army. It's secured by several armoured doors and blast-proof chambers.

OIL DEPOT Jurong Rock Caverns took seven years to build and cost nearly $1 billion. It saves a space equivalent to 70 football fields on the surface.

urban planner Alex Marshall. "When you can't go up and you can't go out, you go down." While other cities limit themselves to metro systems, Singapore is building a twin city underground. Since 2015, the state has owned the 'land' 30 metres below the city and is selling it off bit by bit – with access to the surface included. "There's unlimited potential," says Lim Eng Hwee, Singapore's chief urban planner.

The subterranean city will be organised in distinct layers with offices, mall and transport systems directly under the surface. The Underground Science City, a research centre for 4,200 scientists with 40 linked rock caverns of approximately 25 metres in height, will be located at a depth of 50 metres. Keep on going and a further 50 metres down there'll be a huge weapons depot for Singapore's army, the only one of its kind in the world. Granite and a sophisticated system of tunnels and blast-doors will ensure that an accidental explosion does not lead to tragedy. The construction work will mean that an area the size of 400 football pitches will be free on the surface.

Singapore will store oil 150 metres below the surface in nine giant, nine-storey-high containers. They'll be able to hold 580 Olympic swimming pools-worth of oil. Above ground, this will free up an area the size of 70 football pitches.

But this is only the beginning: authorities expect Singapore will house seven million citizens by 2050. "The people will live and work in vast subterranean halls that will make today's shopping malls look like tiny cellars," says a spokesperson from the Urban Redevelopment Authority.

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DEEP-SEA OIL DEPOT

Singapore is only half the size of London, but it's the world's third largest oil refining hub. The city's secret? The Jurong Rock Caverns...

Tankers from across the globe dock in Singapore: before it's processed, the crude oil flows into a gigantic underground storage facility – the Jurong Rock Caverns. These caves can hold 1.5 million cubic metres of the stuff – roughly the amount consumed by the UK in a week. The technicians must constantly control three highly sensitive flows: the inflow (red) and outflow (green) of oil, and the seepage water (blue) that enters naturally.

HOW DOES OIL GET BACK INTO THE GROUND?

A tanker pumps oil into containers from the ship.

The control block connects the port's pipelines with those of the containers.

A flow meter controls the rate and amount of the incoming oil.

Seepage water is purified in this plant before being returned to the ocean.

Sea

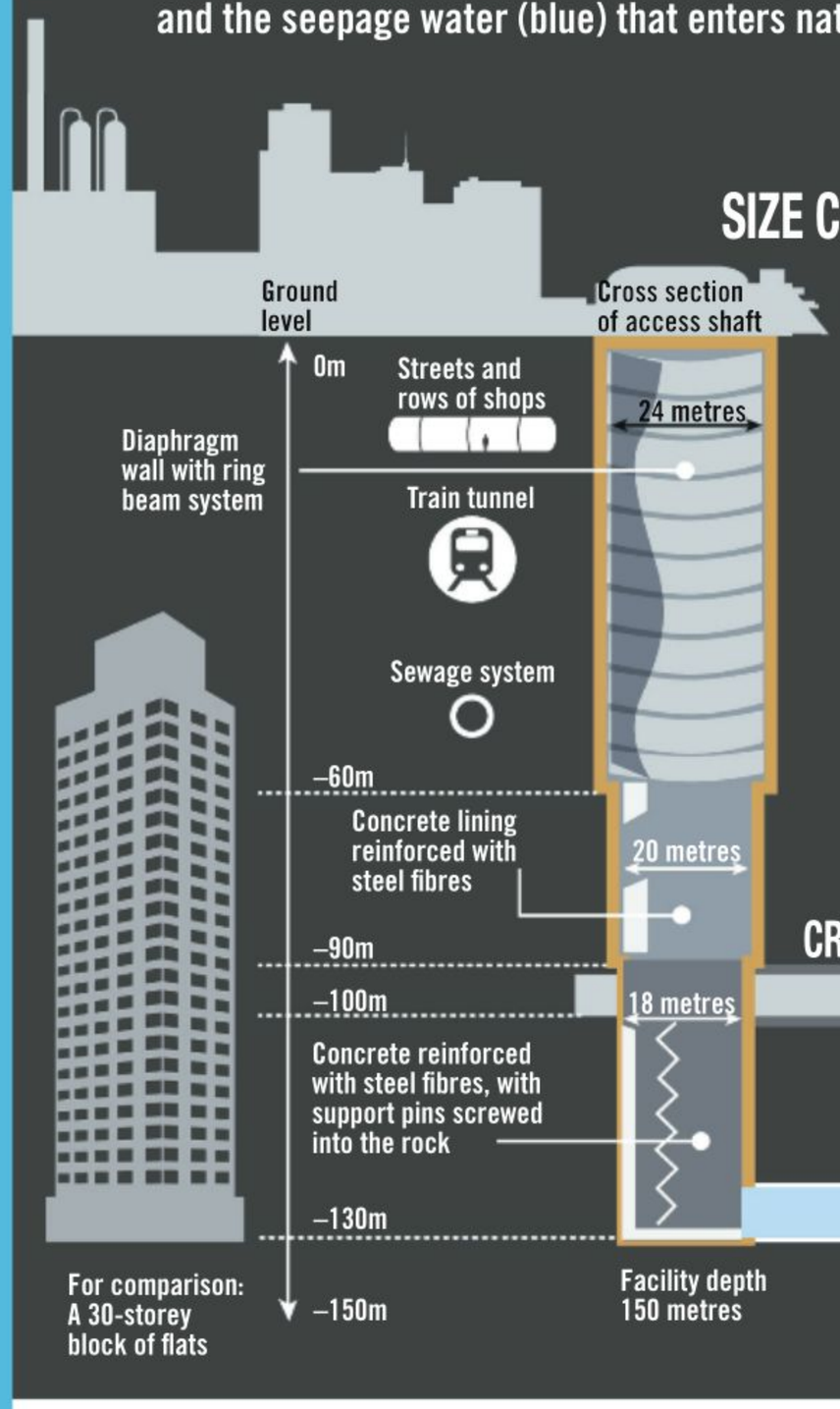
Access tunnel

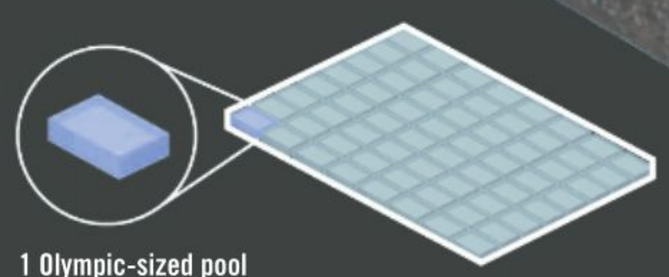
Operational tunnel

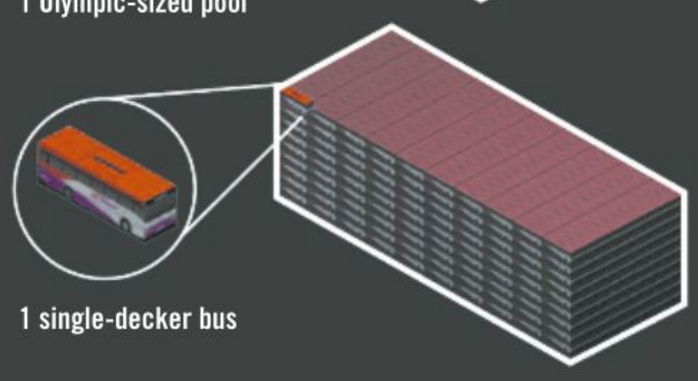
Outflow of oil
Seepage water pump
Inflow of oil

340 metres

SIZE COMPARISON

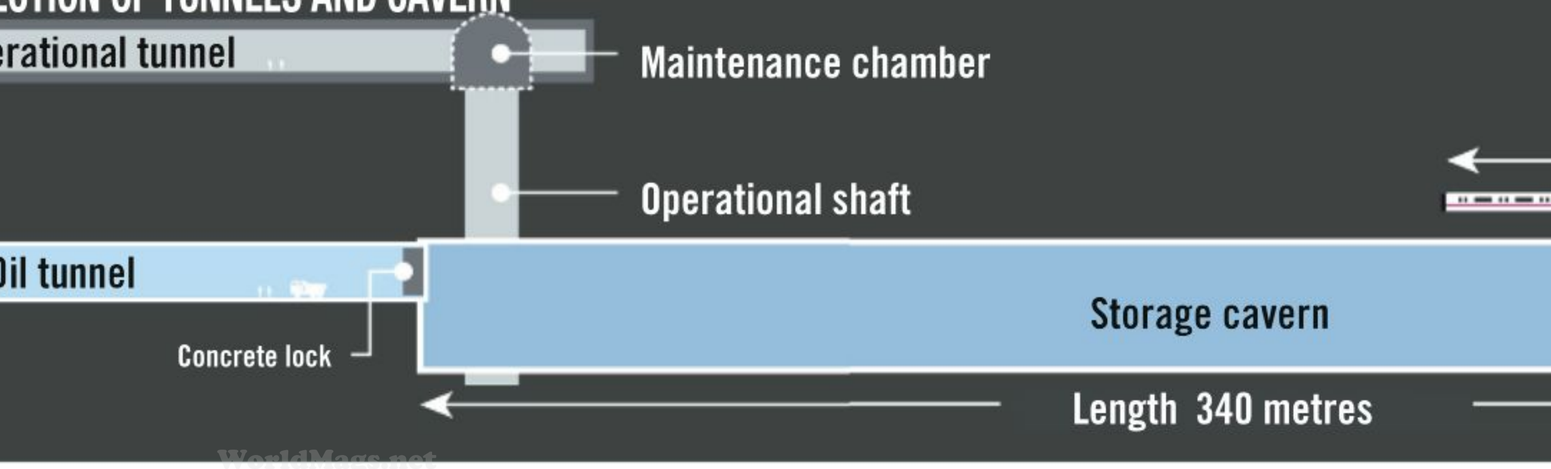






Each of the nine chambers has a storage capacity of 165,000 cubic metres, which is the same as 64 Olympic-sized swimming pools or 1,300 buses.

CROSS SECTION OF TUNNELS AND CAVERN



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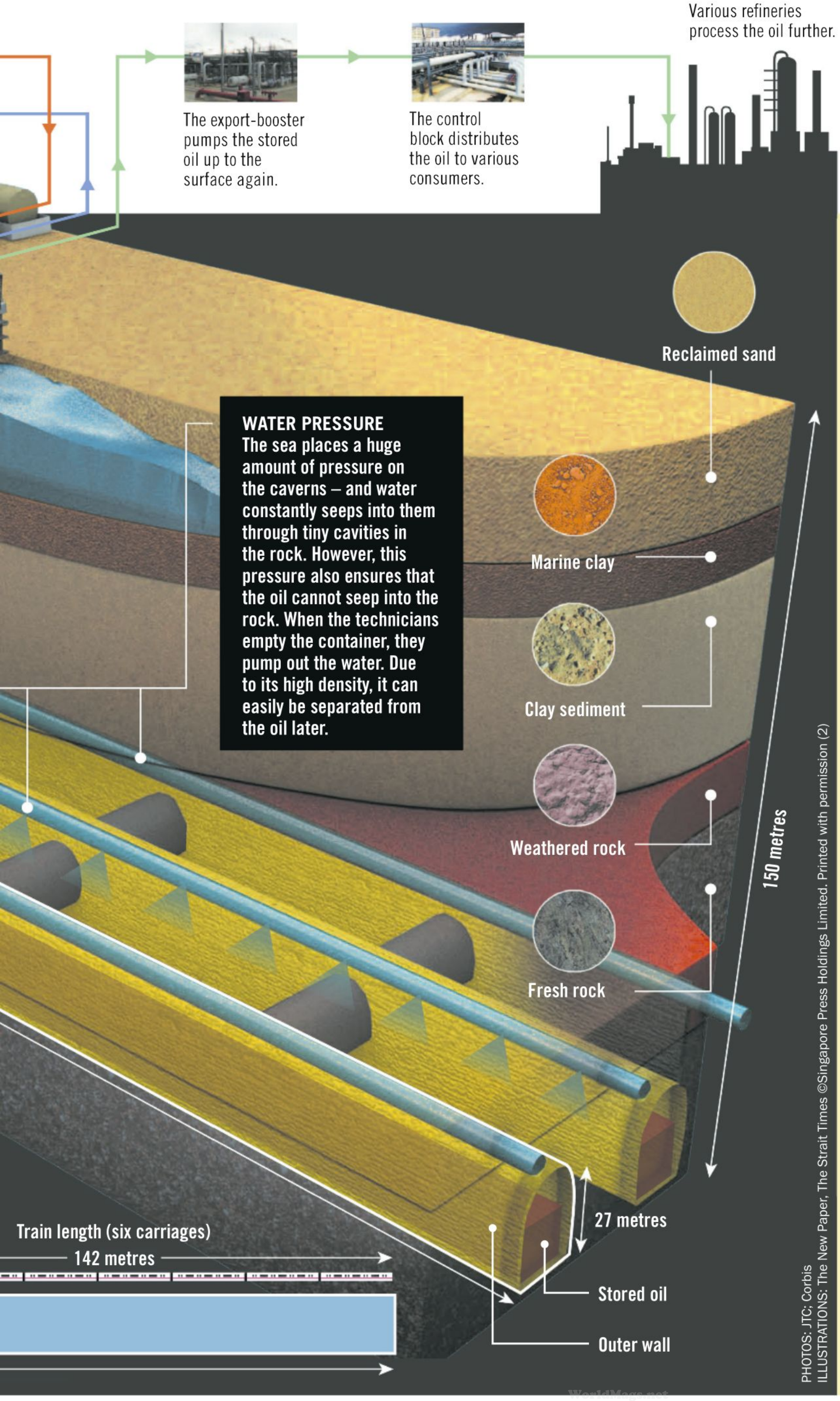

HOW DO YOU CREATE AN ARTIFICIAL OIL FIELD?

1. SURVEYING
The layout of the tunnel is mapped out in detail by surveying equipment.

2. DRILLING AND CHARGING
A computer-controlled drill bores 5-metre-deep holes, filling them with explosives.

3. DETONATION
The explosives are detonated: each explosion extends the tunnel by around 4 to 4.5 metres.

4. VENTILATION AND REMOVAL
Pressurised air carries the dust away. The rubble and rocks are then removed.

5. STRAIGHTEN
A pneumatic hammer is used to cut away cliffs and slopes so that straight walls are formed.

6. CONCRETE
Concrete insulation is sprayed onto the rock face at high pressure.

7. LOCK
Support bolts are put in place to keep the rock face in place and ensure the ceiling does not collapse.

PHOTOS: JTC; Corbis
ILLUSTRATIONS: The New Paper, The Straits Times ©Singapore Press Holdings Limited. Printed with permission (2)

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[AND FINALLY]

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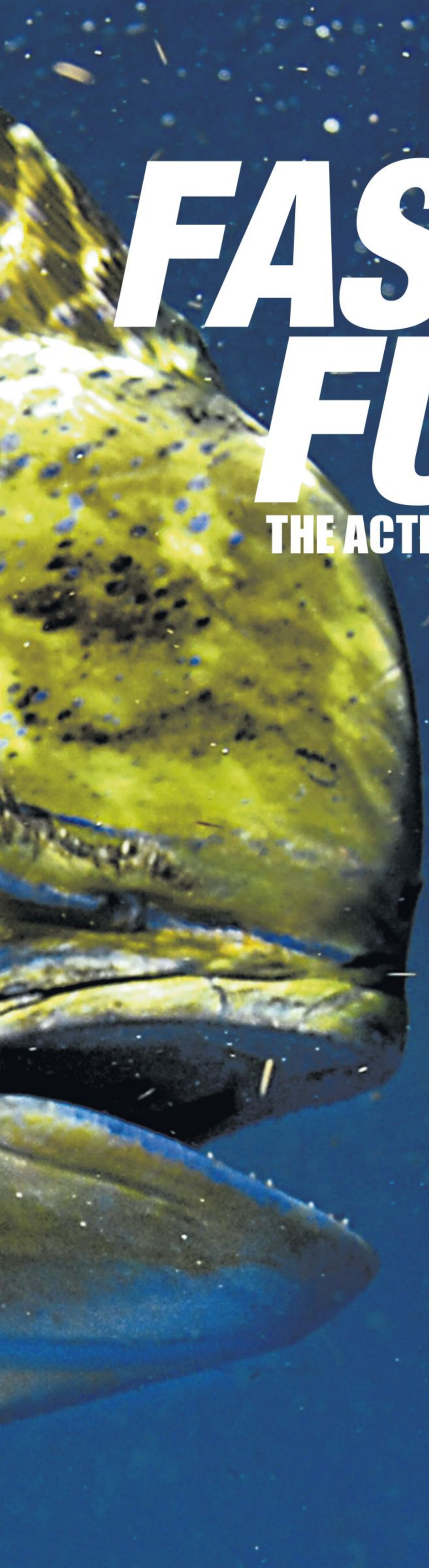
FAST & FURIOUS

THE ACTION-PACKED LIFE OF A MAHI-MAHI



The mahi-mahi is one of the fastest fish in the world. The high-speed hunter spends every hour of every day with just one thing on its mind: survival. Eat or be eaten – it's a life on the limits...

The speed is breathtaking and too fast for the human eye: with a few flicks of its fins, the mahi-mahi – also known as the dorado – accelerates to almost 50mph in just two seconds. Now only a few centimetres separate it from its prey, a flying fish. Leaping out of the waves, the hapless flying fish makes one last desperate attempt to escape the high-speed hunter – but it's all in vain as the green-gold predator follows it out of the water. Catapulting its 15kg body two metres above the sea, *Coryphaena hippurus* plucks the flying fish out of thin air and devours it in an instant, before diving back into the depths once more. Back in the water our streamlined action hero immediately sets its sights on a new victim, and the hunt begins all over again…

The mahi-mahi lives life in the fast lane – hardly surprising since the tropical torpedo has no time to lose. You see, the fish needs to eat as much as possible in as short a time as possible in order to grow as large as possible as quickly as possible. Quite a tongue-twister – but the logic behind it is very simple: it's so that it doesn't fall victim to other predatory fish. All this hunting means young mahi-mahi put on up to a kilo a month and grow up to five centimetres every week. Kilo for kilo, hardly any other animal grows at such a rate. And yet, astonishingly, only 1% of mahi-mahi survive to see their first birthday. Those that do, develop into true killing machines with no natural enemies to fear. Too fast and agile for any shark, they spend every waking moment on the hunt for something to eat. And even when nature gives their prey wings, the mahi-mahi sees no reason to give up. After all, there's nothing like a flying stunt to liven up the day…

PHOTO: Jason Arnold

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Letters

*Letters may be edited for publication

Next issue on sale **March 24th**

Welcome to *Wonderpedia*'s Letters page, where you can share your thoughts on anything you see in the magazine. Write to us at *Wonderpedia*, Academic House, 24-28 Oval Road, London NW1 7DT or email editorial@wonderpedia magazine.co.uk

Zika link?

DEBBIE CALDWELL, BY EMAIL

I've been following the development of the Zika virus with both interest and alarm, having found your previous coverage of viruses like Ebola very informative. Recently I heard that a link between Guillain-Barré Syndrome ('Suddenly Frozen!', February) and Zika virus is being investigated. Could you explain more about this?

> *The Zika virus is spread by the Aedes aegyptus species of mosquito and causes mild flu-like symptoms, but is primarily feared in light of its suspected links to severe birth defects in children born to infected mothers. It has been spreading across South America since May 2015. Now, medics are noting another possible complication. Guillain-Barré syndrome (GBS) which, as this magazine reported last month, is a rare immune disorder causing nerve weakness, paralysis and – in the most severe cases – death. In French Polynesia health officials first observed a jump in GBS cases in tandem with a Zika outbreak. Similar correlations have now been recorded in Colombia and El Salvador where several patients have died. Though a direct link has not yet been confirmed, scientists continue to investigate.*

The high life

OLIVER JESSOP, BY EMAIL

The piece on the ten deepest divers in the animal kingdom ('Q&A', February) was fascinating. On the other end of the scale, which animal can fly highest?

> *The highest-flying bird is the bar-headed goose, which migrates over the world's highest mountain range, the Himalayas. The birds have been tracked flying at heights above 6,420 metres. Their small bodies are specially adapted to the hypoxic air at such altitudes, where there is a third less oxygen than at sea level. Their hearts contain more blood vessels than other birds, their lungs (larger than in other waterfowl) extract oxygen more efficiently and their red blood cells have also adapted to load more oxygen to the blood than other vertebrates are able to.*

For more questions, answers and fascinating facts, visit our Facebook page: www.facebook.com/wonderpediamagazine

Sphere of influence

AARON HOWARD, BY EMAIL

Nice piece on the shrinking moon last month ('Is The Moon Shrinking?', February). Is there any reason why planets are always round?

> *The planets are, in fact, not quite round. They're almost spherical, but we'll get to that later. The answer, regardless, lies with gravity. As our solar system was forming, gravity caused billions of gas molecules and pieces of dust to gather into swirling clouds which, over time, grew larger and larger. Remember, the larger an object is, the stronger its gravitational field. Gravity pulls uniformly in all directions so the obvious outcome is a sphere. As the clouds swelled in size, forming planets, their gravitational force also increased, pulling material inwards. So the greater the gravity, the closer to a perfect sphere a planet will be. But the planets in our solar system are a way off that: because they spin, their spinning force works against gravity, which is why many planets – Earth included – bulge around their equators and flatten out at the poles. The technical name for such a shape is an oblate spheroid and applies to all of the planets which orbit the sun.*

Sting in the tail

ADITI PRAKASH, BY POST

I always savour the nature articles in *Wonderpedia* – 'The Best Nature Photos Of The Year' (February) was breathtaking. The one of the gorilla holding the butterfly was unbelievable! On a similar insect-related note: why do bees die when they sting you?

> *Honeybees sting when they perceive a threat to their hive – but they pay a high price for this act of self-defence. That's because a honeybee's stinger is composed of two spiked hooks. When it stings, these hooks pierce the unlucky victim's skin. But the bee is unable to pull its stinger back out: part of its digestive tract, muscles and abdomen are ripped from its body as it attempts to fly away. It's an injury that no bee can survive – fatal abdominal rupture. Honeybees are the only species of bee or wasp to suffer this grisly fate: they sacrifice themselves to save their hive.*

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